Natural England Commissioned Report NECR165

Condition assessment of Thanet Coast Special Area of Conservation

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

The report was commissioned to survey the Thanet coast SAC and report on the extent and condition of biotopes present; and to determine the species richness, abundance and assemblage composition of the benthic species present.

The Thanet coast SAC is comprised of chalk reef habitats of National and International importance. The Thanet coasts chalk reef is considered some of the best examples of their kind (English Nature 1995), specifically the presence of unusually rich littoral algal flora, and the presence of submerged and partially submerged sea caves.

The coastline supports a diverse range of fishing activities, including trawling, netting and potting. There are a number of commercially important species present off the Thanet coast including the Atlantic cod (*Gadus morhua*), European seabass (*Dicenbrarchus labrax*) and the European lobster (*Homerus gammarus*). The area also supports a wide range of recreational activities including angling, sailing, bird watching and SCUBA diving.

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Further information
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Condition assessment of Thanet Coast Special Area of Conservation

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1 Introduction

Thanet, situated in Southeast England (Figure 1.1) is home to chalk reef habitats that are considered to be of national and international conservation importance. The chalk habitats and their associated communities are uncommon in Europe and considered to be one of the best examples of their kind (English Nature 1995).

The Thanet coast supports diverse commercial fishing activities including trawling, netting and potting (Thanet Coast Project). Commercial species in this area include the common whelk *Buccinum undatum*, European seabass *Dicentrarchus labrax*, skates and rays, sole *Solea solea*, European lobster *Homarus gammarus* and Atlantic cod *Gadus morhua* (MMO 2013).

The Thanet coast also supports a range of recreational activities including angling, sailing, bird watching and SCUBA diving (Thanet Coast Project).

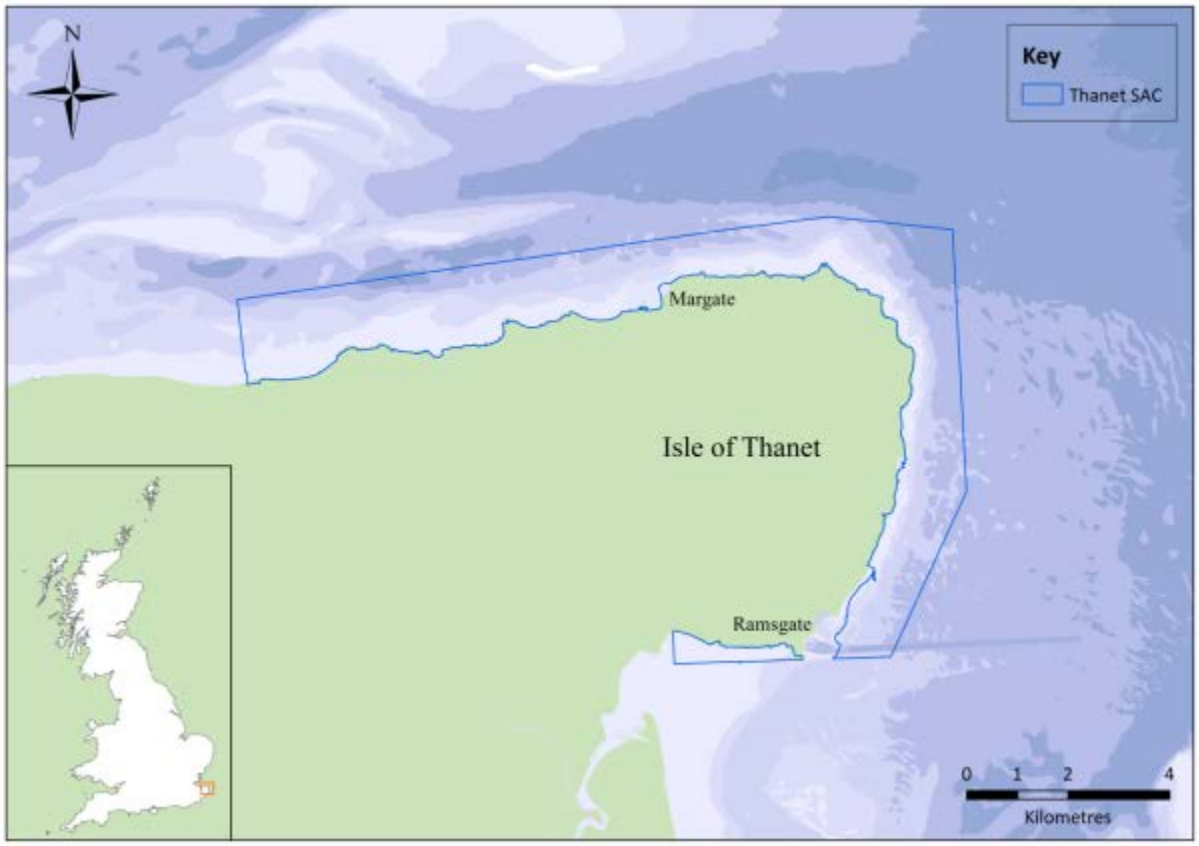

Figure 1.1 Location of Thanet Coast SAC

1.1 Thanet Coast SAC

The Thanet coast was designated as a 2803.84 ha Special Area of Conservation (SAC) under the EU Habitats Directive (92/43/EEC) for its features of European importance (JNCC) (Figure 1.1). The two Annex I habitats present in Thanet are described in the following subsections, based on information from the Joint Nature Conservation Committee (JNCC).

1.1.1 1170: Chalk Reefs

- Presence of unusual reef communities

- Thanet coast is the longest continuous stretch of coastal chalk in UK
- Thanet Coast contains 20 % of UK chalk reefs and 12 % of European chalk reefs
- Infralittoral kelp forests are characteristically absent on the Thanet Coast due to the high turbidity of the water
- Presence of unusually rich littoral algal flora

1.1.2 8330: Submerged or partially submerged sea caves

- Thanet Coast provides the second most extensive representation of chalk caves in the UK
- Some submerged caves in Thanet extend up to 30 m into the cliffs, reaching 6 – 10 m in height
- Thanet Coast sea caves support specialised algal and lichen communities

1.2 Habitat-types surrounding Thanet

1.2.1 Circalittoral rock

Circalittoral rock is composed of bedrock, boulders and pebbles which extend into the aphotic zone, and, is characterised by highly variable faunal communities.

1.2.2 Sublittoral sediment

Sediment habitats in the sublittoral near shore zone, extending from the extreme lower shore to 200 m. Sediment is composed of varying amounts of cobbles and pebbles on sand, mud and mixed sediment.

1.3 Survey aims and objectives

- Aim: to survey Thanet Coast SAC and report on the extent and condition of biotopes
- Objectives:
    - Conduct video survey in Thanet.
    - Analyse video to determine the biotopes present in Thanet.
    - Identify and enumerate benthic species for statistical analysis of species richness, abundance and assemblage composition and eight indicator species.
    - Suggest recommendations for future survey work.

2 Methods

Survey work was completed by Plymouth University Marine Institute during July 2013. Work was carried out aboard *Silver Lining,* operating from Ramsgate Harbour working alongside local skipper Paul Cannon from Audacious Marine.

2.1 Survey method

A High Definition (HD) video camera was mounted on a towed flying array to survey the benthic communities (detailed methods are described in Sheehan et al. 2010) adapted from (Stevens & Connolly 2005)). The system floats above the seabed and altitude is controlled using a drop-weight between the boat and the sled, and a length of rope acts as a weak-link between the sled and a drag-chain. The flying system is relatively non-destructive, which is important for sampling protected areas and is able to survey a range of habitats from bedrock and boulders to sediments without snagging. The HD video system comprises a camera (Surveyor-HD-J12 colour zoom titanium camera, 6000 m depth rated, 720p) positioned at an oblique angle to the seabed, three LED lights (Bowtech Products limited, LED-1600-13, 1600 Lumen underwater LED) fixed to the array in front of the camera to provide improved image definition and colour, a mini CTD profiler (Valeport Ltd) and two laser pointers (wavelength 532 nm Green) set 30 cm apart. The umbilical was connected topside to a Bowtech System power supply/control unit. This allowed control of the camera, focus, zoom and aperture, and intensity of the lights.

12 Areas were surveyed; six inside the SAC and six outside of the SAC (Open) (annotated on Figure 2.1). Three replicate 200 m x 0.5 m transects (Sites) were recorded in each Area. Locations of Areas and Sites were selected to provide representative spatial coverage of the site. At each preselected Site the flying array was deployed and towed slowly behind the boat (0.3-0.5 knots). Position data were recorded using differential GPS and hydrographic surveying software (Hypack 2013).

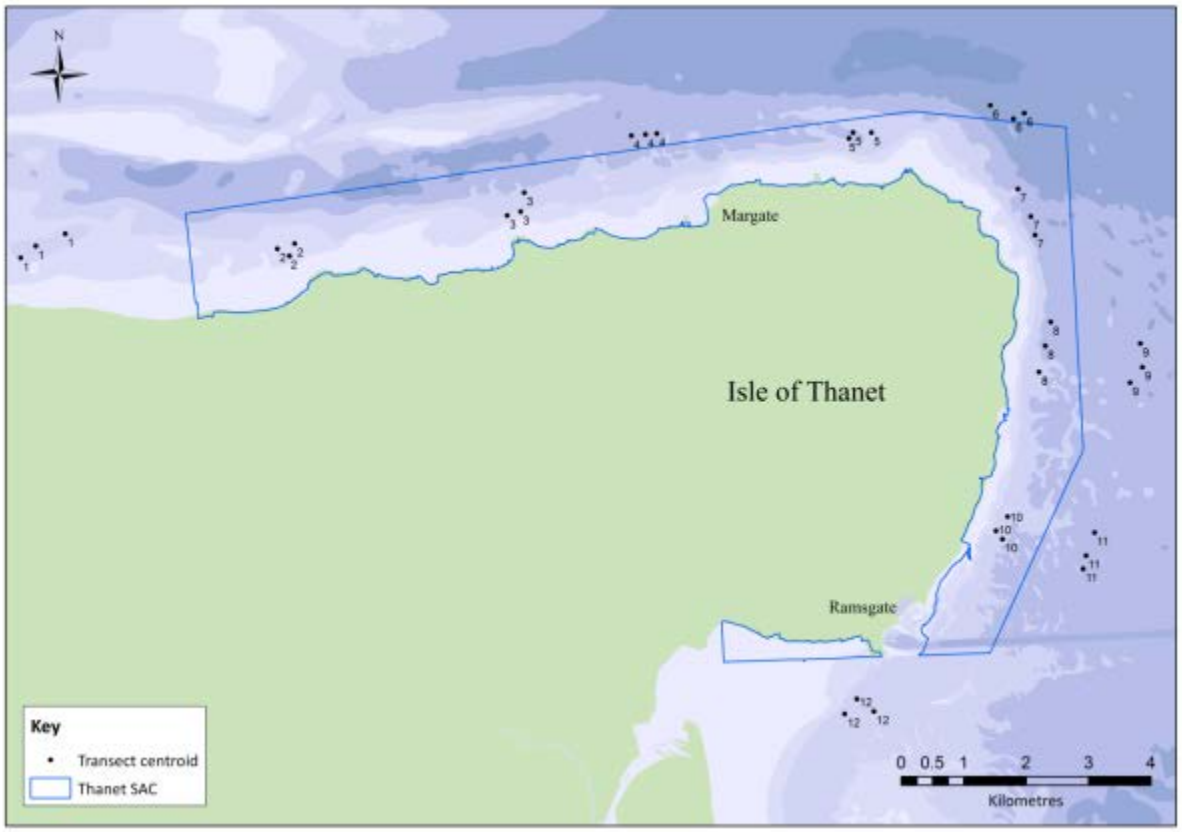

Figure 2.1 Survey areas in Thanet, presented as transect centroids

2.2 Video analysis

Video analysis comprised three approaches; frame grab analysis, biotope assessment and video transect analysis. Species richness, abundance, assemblage composition, biotope classification and eight indicator taxa were enumerated. Four sessile taxa (*Alcyonidium diaphanum, Alcyonium digitatum*, Flustridae and Hydroids) and four mobile/sedentary taxa (*Asterias rubens, Ophiura ophiura, Pagurus bernhardus* and *Urticina felina*) made up the indicator species. Sessile taxa were enumerated using the frame-grab data and the mobile/sedentary indicator species were enumerated using the video transect data.

Frame grab analysis required the processing of footage using automated frame extracting software (Cybertronix, UK). Obscured or blurred frames or those in which the array is flying too close to, or too far from the seabed were discarded. 30 frames were then selected at random and all species present were quantified to provide abundance and species richness data. The use of 30 frames per transect for this type of analysis has been shown to provide a robust biological dataset without compromising accuracy, or becoming overly time-consuming. For each frame a digital quadrat was overlaid (Figure 2.2). Within the quadrat, organisms were counted unless they were encrusting, in which case their percentage cover was calculated. Data were then standardised and presented as density (individuals m^{-2}) or % cover.

For video transect analysis, footage was viewed at normal speed, pausing to record each species observed, along with details of substrate. This approach was used only to record mobile or rare flora and fauna, which might not be represented by frame grab analysis. Data were then standardised and presented as density (individuals m^{-2}).

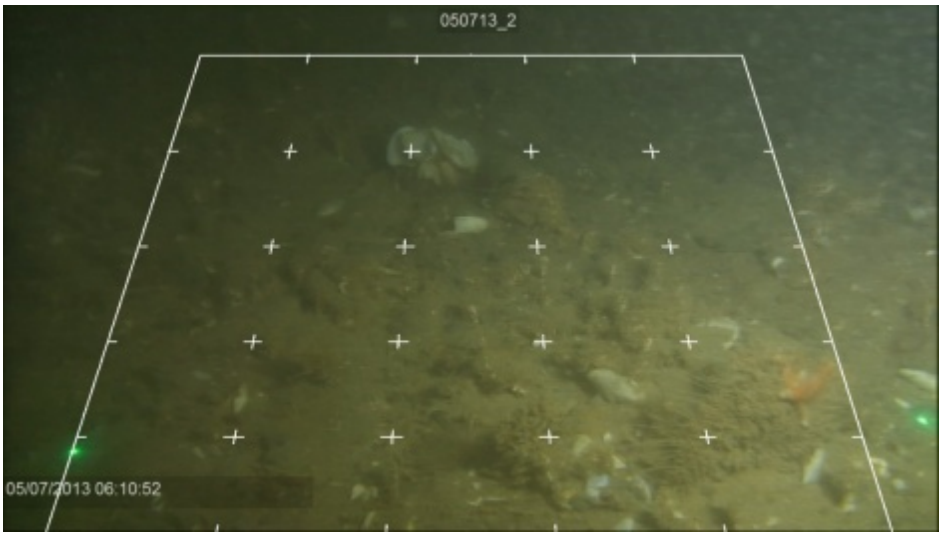

Figure 2.2 Frame grab showing digital overlay with 16 cross-hair points

2.3 Biotope classification

Biotopes were assigned to the same 30 frame grabs per transect which were used for frame grab analysis. In order to obtain the greatest level of classification possible, video footage from immediately before and after the frame were used to evaluate and assign biotopes. Biotopes were assigned according to the identifiable species and substrate observed.

2.4 Statistical methods

Univariate (species richness, abundance and indicator species) and multivariate analyses (assemblage composition) were conducted using Permutational Multivariate Analysis of Variance PERMANOVA in PRIMER 6 (Anderson 2001, Clarke and Warwick 2001), based on similarity matrices (univariate = Euclidean distance, multivariate = Bray Curtis similarity). Univariate data were Log (x+1) transformed and multivariate were 4^{th} root transformed (Anderson and Millar 2004). The null hypothesis of no difference among species assemblages between Treatments (SAC or Open controls) and Areas nested in Treatments (six per treatment) was examined. Three replicate 200 m transects were surveyed per Area.

2.5 Quality assurance

Video analyses were repeated for 10 % of the data by a second experienced worker to ensure reproducibility. Discrepancies were resolved and datasets altered accordingly.

2.6 Limitations

While the flying array has many advantages over SCUBA surveys, such as coverage, cost-effectiveness, time-effectiveness and reproducibility, there are some limitations. The flying array is designed to capture footage of epibenthic communities, and therefore does not permit quantification of infaunal assemblages. Additionally, biotope classifications were developed with dive surveys in mind, causing difficulties in allocating some biotopes using video analysis. Furthermore, identification to species level is not always possible using video analysis techniques so these species are grouped. For example, erect sponges such as *Axinella dissimilis*, *Raspailia* spp., *Haliclona oculata* and *Stelligera* spp. can appear similar and have been classed as taxonomically difficult (Ackers et al. 2007). Poor visibility may prevent or reduce the quality of surveys in areas prone to high turbidity, and have been reported as a problem in previous surveys conducted in Thanet (Tittley et al. 1998).

3 Results

7,200 m of seabed were surveyed and 1080 frame grabs were analysed. 57 species were identified in Thanet, of which 50 were observed in frame grabs and 19 were recorded during video analysis. The water visibility at Thanet was fairly bad, which makes benthic survey using video extremely challenging. Despite the poor visibility it was still possible to assess biotope composition and identify sufficient taxa to assess assemblage composition (Figure 3.1). Overall, 11 biotopes were present. There were many structure forming organisms such as dead man's fingers *Alcyonium digitatum*, yellow branching sponges and Flustridae. Some fishes were observed, such as small-spotted catsharks *Scyliorhinus canicula* and gobies. It was also possible to identify other taxonomically distinct species such as common star fish *Asterias rubens*, Dahlia anemones *Urticina felina*, sea chervil *Alcyonidium diaphanum* and tube worms *Sabella pavonina*.

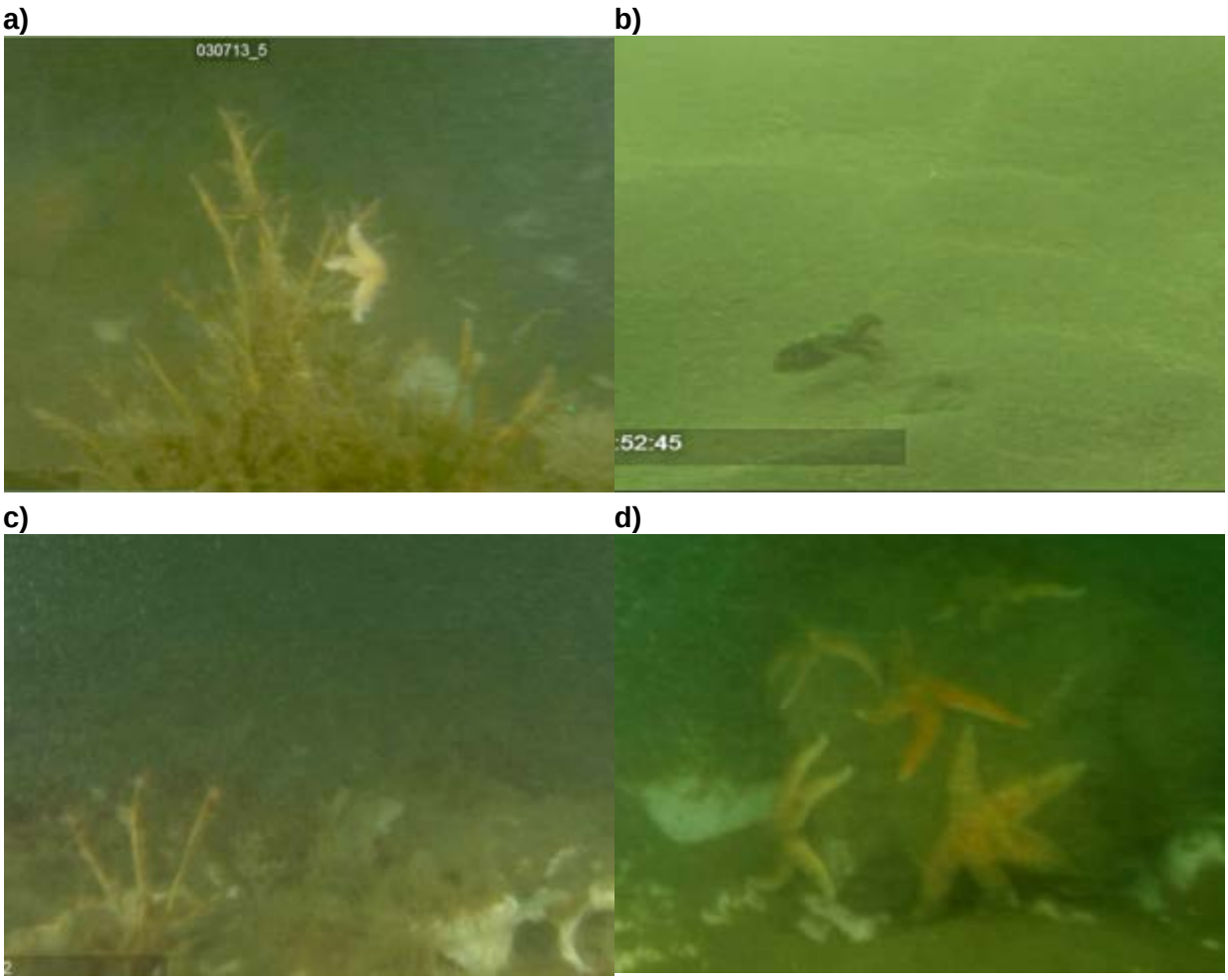

Figure 3.1 Images of Thanet a) *Asterias rubens* on *Tubularia indivisa* b) little cuttlefish *Sepiola atlantica* emerging from the sand c) *Tubularia indivisa* among hydroid species and red algae on chalk bedrock d) *Asterias rubens* aggregated on a turf covered boulder

3.1 Condition and extent of biotopes

Four circalittoral rock biotopes were recorded in Thanet, while sublittoral sediment was shown to support seven biotopes. Figure 3.2 shows the biotope by frame for each transect. Transect centroid coordinates and dominant biotopes for each transect are summarised in the Appendix, Table A1 and Figure A1. The habitat types described in section 1.2 have been

used to divide biotopes for interpretation. Since biotopes will vary in terms of their species composition depending on geographic location, the specific characteristics and condition of biotopes recorded within the Thanet survey area have been described in the following subsections. Furthermore, Table A2 in the Appendix contains full details of dominant species associated with each biotope.

3.1.1 Circalittoral rock biotopes

Circalittoral rock biotopes were identified to the north and east of Thanet. Exposed circalittoral rock biotopes were present due to the strong tidal currents which surround Thanet, including bare rock devoid of macro fauna (**CR.HCR**). Conversely, complex assemblages of faunal turf (**CR.HCR.XFa.SpNemAdia**) were also recorded in the broad survey area (Table 3.1).

Table 3.1 Local circalittoral rock biotope classifications

Biotope code	Qualifying characteristics	Additional notes
CR.HCR	Circalittoral rock in high energy environment. Devoid of macrofauna.	No visible species present.
CR.HCR. XFa	Mixed faunal turf, dominated by hydroids	No other macrofauna.
CR.HCR.XFa.Mol	Rocky, hard ground. May be covered with a thin layer of silt/sand. *Tubularia spp* dominant, other hydroids present. Sparse *Flustra foliacea* may occur.	*Molgula manhattensis* does not occur in dense aggregations in Thanet. Other characteristics permit allocation of this biotope.
CR.HCR.XFa.SpNemAdia	Sparse sponges (very few observed in frame grabs) *Nemertesia spp*. and other hydriods with *Alcyonidium diaphanum* on circalittoral mixed substrata.	

3.1.2 Sublittoral sediment biotopes

Sublittoral sediment biotopes were recorded within and outside of Thanet SAC, and were present in all but two survey areas (Areas 4 & 6). Thanet is known for its highly turbid water column which limits the availability of light, with consequent effects on benthic assemblages in the area. Faunal species dominate even in shallow water. For a summary of characteristics defining biotopes at Thanet, see Table 3.2.

Table 3.2 Local sublittoral sediment biotope classifications

Biotope code	Qualifying characteristics	Additional notes
SS.SCS.ICS	Coarse sand and gravel in the infralittoral. Characterised by infauna.	
SS.SCS.ICS.SLan	*Lanice conchilega* in coarse to medium fine gravelly sand in the shallow sublittoral.	
SS.SMx.CMx.FluHyd	Mixed sediment which is sand dominated but with boulders cobbles and pebbles. Rocks tend to be sand scoured. Flustra and hydroid species such as *Hydrallmania falcata*, *Nemertesia antennina*, and *Halecium halecinum* are dominant.	Kelp, red algae and sparse *Mytilus edulis* can occasionally be present.
SS.SMx.IMx	Circalittoral mixed sediment.	Not enough species present to assign a higher level.
SS.SSa.IFiSa	Infralittoral fine sand.	
SS.SSa. IFiSa. IMoSa	Medium to fine sand and very occasional small pebbles with No/Sparse fauna.	
SS.SSa.IFiSa.ScupHyd	Shallow sands with cobbles and pebbles. Colonies of hydroids, *Flustra foliacea, Balanus crenatus* and *Alcyonidium diaphanum* on cobbles and *Urticina felina* and occasional *Lanice conchilega* on sand.	

3.1.3 Extent

The extent of biotopes throughout the broad survey area surrounding Thanet are shown in Figure 3.2, which indicates the dominant biotope for replicate transects within survey areas. Furthermore, the 1080 frame grabs analysed for biotope classifications are summarised in Table 3.3. Here it can be seen that some biotopes were very rarely assigned (**CR.HCR** was documented in 0.2 % of analyses), while others were more abundant. For example, **CR.HCR.XFa** was recorded in 24.4 % of analyses. The circalittoral rock biotopes **CR.HCR.XFa** and **CR.HCR.XFa.Mol** represent 42.4 % of the area surveyed, while the sublittoral sediment biotopes **SS.SMx.IMx** and **SS.SSa.IFiSa** were assigned in 29.4 % of analyses.

Table 3.3 Overall biotope list with abundance and percentage occurrence

	Treatment			
	SAC		Open	
Biotope	**Count**	**%**	**Count**	**%**
CR.HCR	2	0.19	0	0.00
CR.HCR.XFa	76	7.04	187	17.31
CR.HCR.XFa.Mol	166	15.37	28	2.59
CR.HCR.XFa.SpNemAdia	40	3.70	26	2.41
SS.SCS.ICS	0	0.00	23	2.13
SS.SCS.ICS.SLan	0	0.00	17	1.57
SS.SMx.CMx.FluHyd	42	3.89	32	2.96
SS.SMx.IMx	50	4.63	63	5.83
SS.SSa.IFiSa	146	13.52	58	5.37
SS.SSa.IFiSa.IMoSa	0	0.00	60	5.56
SS.SSa.IFiSa.ScupHyd	18	1.67	46	4.26

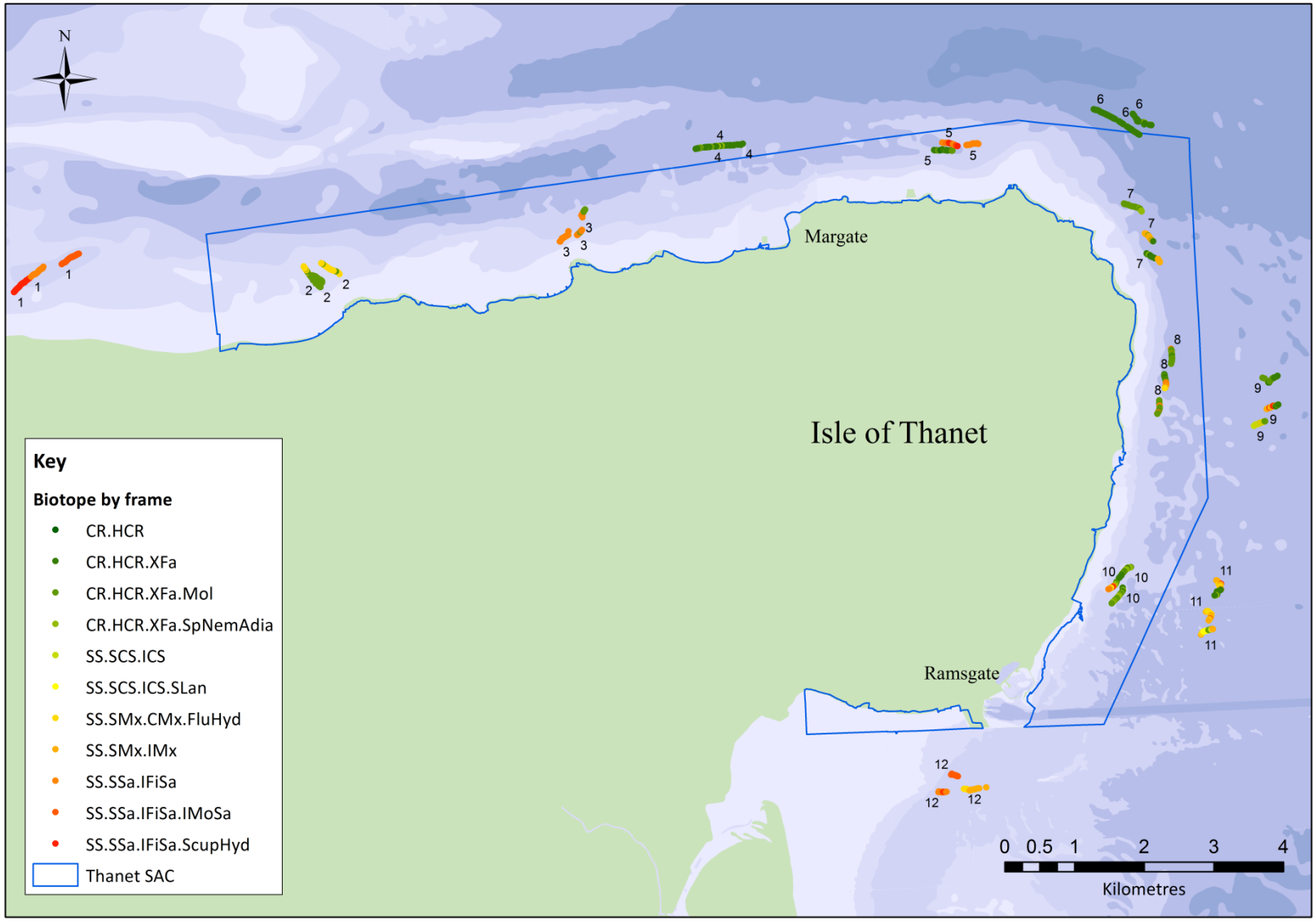

Figure 3.2 Biotope classifications for the 30 frames analysed from each transect. Area numbers annotated

3.2 Biotopes by survey area

In addition to the biotope summaries in Figure 3.2 and Tables 3.1 & 3.2, biotopes are presented in detail (1:10,000) in Figures 3.3 – 3.5 for each survey area. The following subsections describe the specifics of biotopes recorded within each survey area in order to elucidate differences which may exist between similarly classified biotopes in geographically disparate locations. Should further information be required, Table A2 in the Appendix contains a detailed species list for biotopes, listed by survey area.

3.2.1 Area 1 - Open

Area 1 was particularly sandy with sparse epifauna, with swathes of mobile fine sand forming sand dunes. The biotope **SS.SSa.IFiSa.IMoSa** (Figure 3.3) was composed of consistent assemblages throughout the survey area with red algae species recorded only once in this area. No faunal species were recorded since none could be seen above the sand. Where algae species were more abundant and sand was more stable, allowing some hydroid species to establish, the biotope **SS.SSa.IFiSa.ScupHyd** was recorded. The common starfish *Asterias rubens* was recorded on the sand. One entire replicate within Area 1 was assigned the level 3 biotope **SS.SSa.IFiSa.** A greater number of algae species were present in this replicate, and while there may be justifications for assigning the biotope **SS.SSa.IFiSa.IMoSa** or **SS.SSa.IFiSa.ScupHyd**, owing to the absence of *Sertularia cupressina* and *Hydrallmania falcata* these level 4 biotopes could not be assigned. The anemone *Cerianthid* spp. was seen. Common mobile species seen in this tow were *Pagurus bernhardus and A. rubens*. The masked crab *Corystes cassivelaunus* was also recorded in this biotope.

3.2.2 Area 2 - SAC

Area 2 was dominated by the biotope **CR.HCR.XFa.Mol** (Figure 3.3) which, in this location, comprised hydroid species and mixed hydroid and bryozoan turf. The ascidian *Molgula manhattensis,* which is typically observed within this biotope, was not recorded in Thanet, owing to poor visibility and the presence of hydroids and hydroid & bryozoan turf which may obscure this species. Red algae and the bryozoan *Alcyonidium diaphanum* were also present. Area 2 also encompassed areas of mixed sediment which were assigned the biotope **SS.SMx.CMx.FluHyd**. The species composition of this biotope was similar to that of **CR.HCR.XFa.Mol**, with hydroid species and hydroid and bryozoan turf being abundant where rock, boulders and cobbles were present. Red algae and *A. diaphanum* were also frequent, with occasional Flustridae.

3.2.3 Area 3 - SAC

Area 3 represents a sandy area dominated by the biotope **SS.SSa.IFiSa** (Figure 3.3). In this area, **SS.SSa.IFiSa** is characterized by an abundance of hydroid species and *Lanice conchilega*. Mobile species found here were *Ophiura ophiura* and *Asterias rubens*. The anemone *Metridium senile* was occasionally found. Although this area was predominantly sandy, it also contained zones of hard, circalittoral rock biotope **CR.HCR.XFa.Mol**, which was dominated by hydroid species (including *Tubularia indivisa*) and *L. conchilega*. The anemones *Cerianthid spp, Sagartia elegans* and *M. senile* were found occasionally, as were red algae and *Alcyonidium diaphanum.*

3.2.4 Area 4 - Open

Area 4 presented predominantly faunal assemblages which would not be anticipated in shallow waters of approximately 6 m depth. This may be due to the turbid waters which

characterise the Thanet coast, preventing light penetration which would typically support algal communities in waters of this depth. The biotope **CR.HCR.XFa** was recorded in this area (Figure 3.3). Larger boulders and bedrock were densely covered in hydroid turf with the more conspicuous *Tubularia indivisa* and *Nemertesia antennina* frequently observed. Flustridae were also observed to be growing on the boulders. Among the dense assemblages of hydroids was the plumose anemone *Metridium senile*. Patches of sand between the boulders contained the sand mason worm *Lanice conchilega*. Where *N. antennina* and the robust bryozoan *Alcyonidium diaphanum* could be clearly identified on mixed substrata the biotope **CR.HCR.XFa.SpNemAdia** was recorded. *Alcyonium digitatum* were also found growing on the rock and boulder substrata.

3.2.5 Area 5 - SAC

This area encompassed both circalittoral rock and sublittoral sediment biotopes. Circalittoral biotopes were predominantly **CR.HCR.XFa** (Figure 3.3), which is characterised by an abundance of mixed hydroid species. Other occasional species included *Alcyonidium diaphanum*, branching sponges and *Asterias rubens*. Where possible, the biotope was taken down to the next level **CR.HCR.XFa.Mol**, which had similar species to **CR.HCR.XFa**, with a more frequent occurrence of *Alcyonium digitatum*. Sublittoral biotopes in Area 5 included sandy substrate biotopes **SS.SSa.IFiSa** and **SS.SSa.IFiSa.ScupHyd**. **SS.SSa.IFiSa** in this area was characterised by mixed hydroid species *Lanice conchilega* and *Metridium senile*. These hydroid species were also abundant in zones of **SS.SSa.IFiSa.ScupHyd,** which differs from **SS.SSa.IFiSa** due to the presence Flustridae and *Tubularia indivisa*, with occasional *Alcyonium digitatum*, *A. diaphanum* and *Cerianthid* spp.

3.2.6 Area 6 - Open

The predominant biotope found in Area 6 was **CR.HCR.XFa** (Figure 3.3) which was characterised by the mixed hydroid and bryozoan turf that covered boulders and bedrock in this area. Less frequently, Flustridae were also found growing on the boulders and the anemone *Sagartia elegans* was also present. In the more sandy patches between the boulders sand mason worm *Lanice conchilega* was recorded. There were some areas in which the hydroid *Nemertesia antennina* occurred alongside the bryozoan *Alcyonidium diaphanum* and the biotope **CR.HCR.XFa.SpNemAdia** was recorded although the conspicuous soft coral *A. digitatum* normally associated with this biotope was not observed in this area.

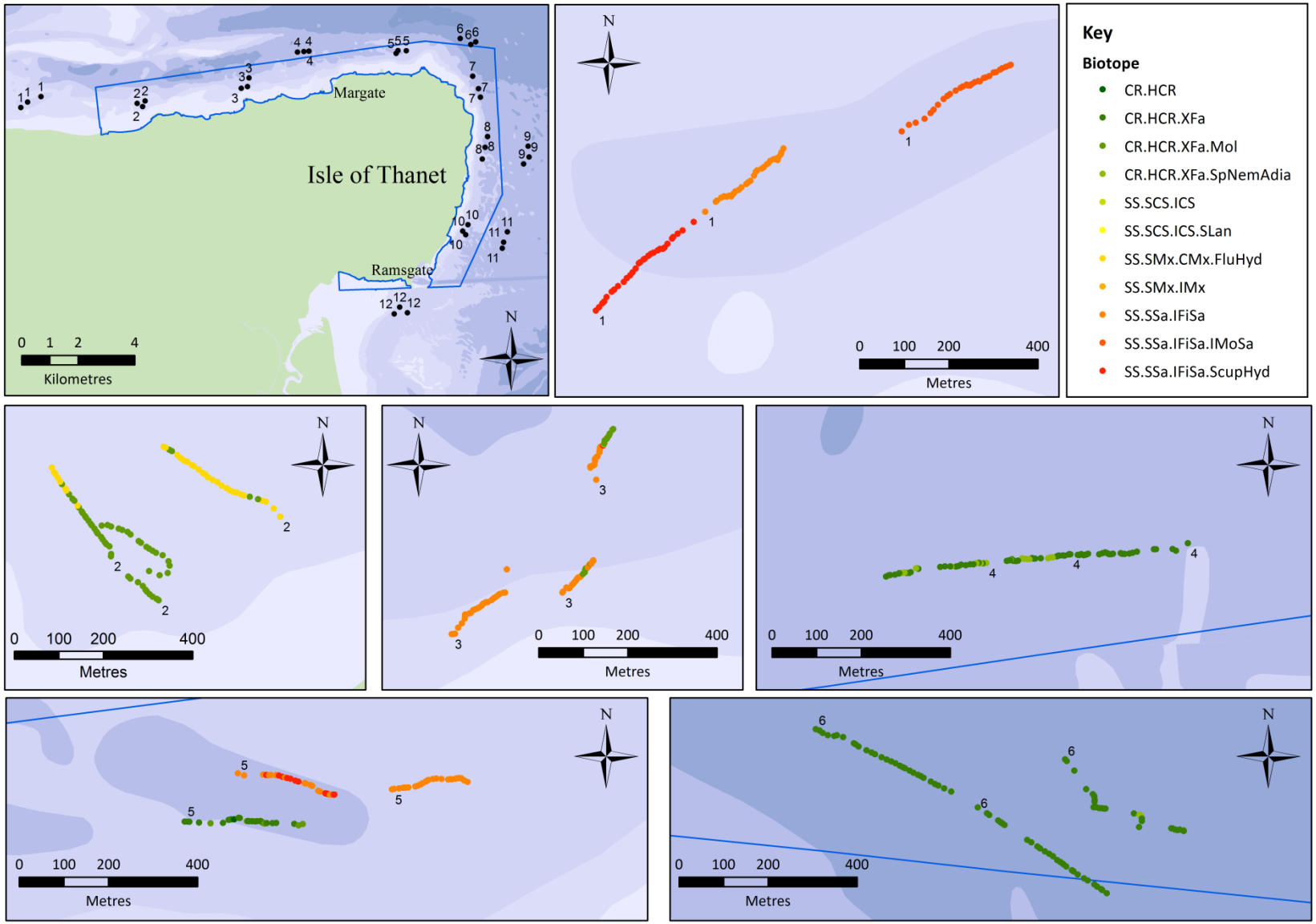

Figure 3.3 Detailed biotope maps (1:10,000) of survey Areas 1 - 6

3.2.7 Area 7 - SAC

This area was dominated by **CR.HCR.XFa** (Figure 3.4) which hosts an abundance of hydroid species. Red algae and *Asterias rubens* were also found to be common. Mixed hydroid and bryozoan turf was found on boulders and cobbles in this area. Other species characterising this biotope include the anemones *Sagartia elegans* and *Urticina felina*. In locations where *Nemertesia antennina* and *Alcyonidium diaphanum* could clearly be identified, the biotope **CR.HCR.XFa.SpNemAdia** was assigned. Also present in this biotope were the anemones *S. elegans* and *Cerianthid* spp., and *Alcyonium digitatum*. Mixed sediment was also present in Area 7 with the biotope **SS.SMx.IMx** assigned to over 40 % of the survey area. Few species were counted within **SS.SMx.IMx** biotopes, with hydroid species (including *Tubularia indivisa*) and *Lanice conchilega* recorded most frequently, and *A. rubens* occurring occasionally.

3.2.8 Area 8 - SAC

Area 8 presented a range of biotopes including **CR.HCR.XFa.Mol** and **CR.HCR.XFa** (Figure 3.4), which were both dominated by an abundance of hydroid species**. CR.HCR.XFa** also includes mixed bryozoan and hydroid turf, on boulders and cobbles in this area. The species *Lanice conchilega, Asterias rubens, Metridium senile* and *Tubularia indivisa* also occur occasionally throughout this biotope in this area. **CR.HCR.XFa.Mol** was also dominated by hydroid species, including an abundance of *T. indivisa and L. conchilega*. Other species recorded occasionally within this biotope included Flustridae, *Alcyonium digitatum* and *A. rubens*. Although the majority of this area was hard circalittoral ground, sublittoral sediments were also recorded. **SS.SSa.IFiSa** was the most frequently encountered sublittoral sediment biotope in Area 8. In this area, **SS.SSa.IFiSa** was characterised by fine sands with sparse fauna, with only a low abundance of *L. conchilega, Pagurus bernhardus* and *A. rubens*.

3.2.9 Area 9 - Open

Area 9 exhibited a range of biotopes. Varied substrate types were encountered, which supported a wide range of species assemblages. Biotopes ranged between circalittoral rock biotopes and sublittoral sediment biotopes (Figure 3.4). **CR.HCR.XFa.Mol** was frequently found in this area at shallow depths in turbid water and was characterised by silt covered hydroid and bryozoan turf on bedrock and cobbles. The hydroid *Tubularia indivisa* often contributed to the hydroid turf found in this area and sparse sponges grew in close proximity to the hydroids. The anemone *Sagartia elegans* was frequently recorded within this biotope, attached to the bedrock. In the sandy patches between the boulders the sand mason worm was commonly observed. In locations where the visibility was poor, a lower level biotope **CR.HCR.XFa** was recorded where a mixed hydroid and bryozoan turf could be seen. The common starfish *Asterias rubens* was often observed in this area within the **CR.HCR.XFa** biotope.

Where sublittoral sediment was present in Area 9, biotopes varied but the most frequently recorded sublittoral sediment biotope was **SS.SCS.ICS**. This was characterised by coarse sediment and was often sparse of any epifauna. Hydroid species were occasionally recorded in this biotope in this area as well as the sand mason worm *Lanice conchilega* and the common starfish *A. rubens.* In locations where the sediment became more heterogeneous with larger cobbles, **SS.SMx.IMx** was recorded. Epifauna in this biotope were sparse, primarily comprising of occasional hydroid species and *A. rubens*. In areas where hydroids were more abundant on infralittoral fine sand the biotope **SS.SSa.IFiSa.ScupHyd** was recorded. The anemone *S. elegans* and tube dwelling anemone *Cerianthid* spp. were present in this biotope.

3.2.10 Area 10 - SAC

Seven different biotopes were recorded in Area 10 (Figure 3.4). Many of these were based on circalittoral rock, with **CR.HCR.XFa.SpNemAdia** occurring frequently. This biotope was characterized by an abundance of hydroid species, including *Tubularia indivisa* and *Nemertesia antennina*. A mixed hydroid and bryozoan turf was found on a high percentage of hard surfaces. Red algae, Flustridae, *Asterias rubens* and orange sponges all occurred relatively frequently in this biotope in this area, with *Alcyonium digitatum* and yellow encrusting sponges occurring occasionally. Also present in Area 10 was **CR.HCR.XFa** which, in this area, is dominated by hydroid species including *T. indivisa* and *N. antennina*. Other species recorded within this biotope include red algae, *A. rubens*, Flustridae, *Urticina felina* and *Buccinum undatum*.

Sublittoral sediment was also recorded in Area 10, with a diverse array of biotopes present. **SS.SSa.IFiSa** was predominant, which was composed of fine sand with sparse epifaunal species, only occasional *Lanice conchilega* were observed. **SS.SSa.IFiSa.ScupHyd** also occurred relatively frequently with *L. conchilega* occurring frequently along with hydroid species including *T. indivisa*. **SS.SMX.CMX.FluHyd** co-occurred with the previous biotopes, and is very similar to **SS.SSa.IFiSa.ScupHyd** in species composition, but occurred on heterogeneous mixed sediment rather than on fine sand. In some instances the biotope **SS.SMx.IMx** was assigned where no conspicuous fauna occurred on mixed sediment.

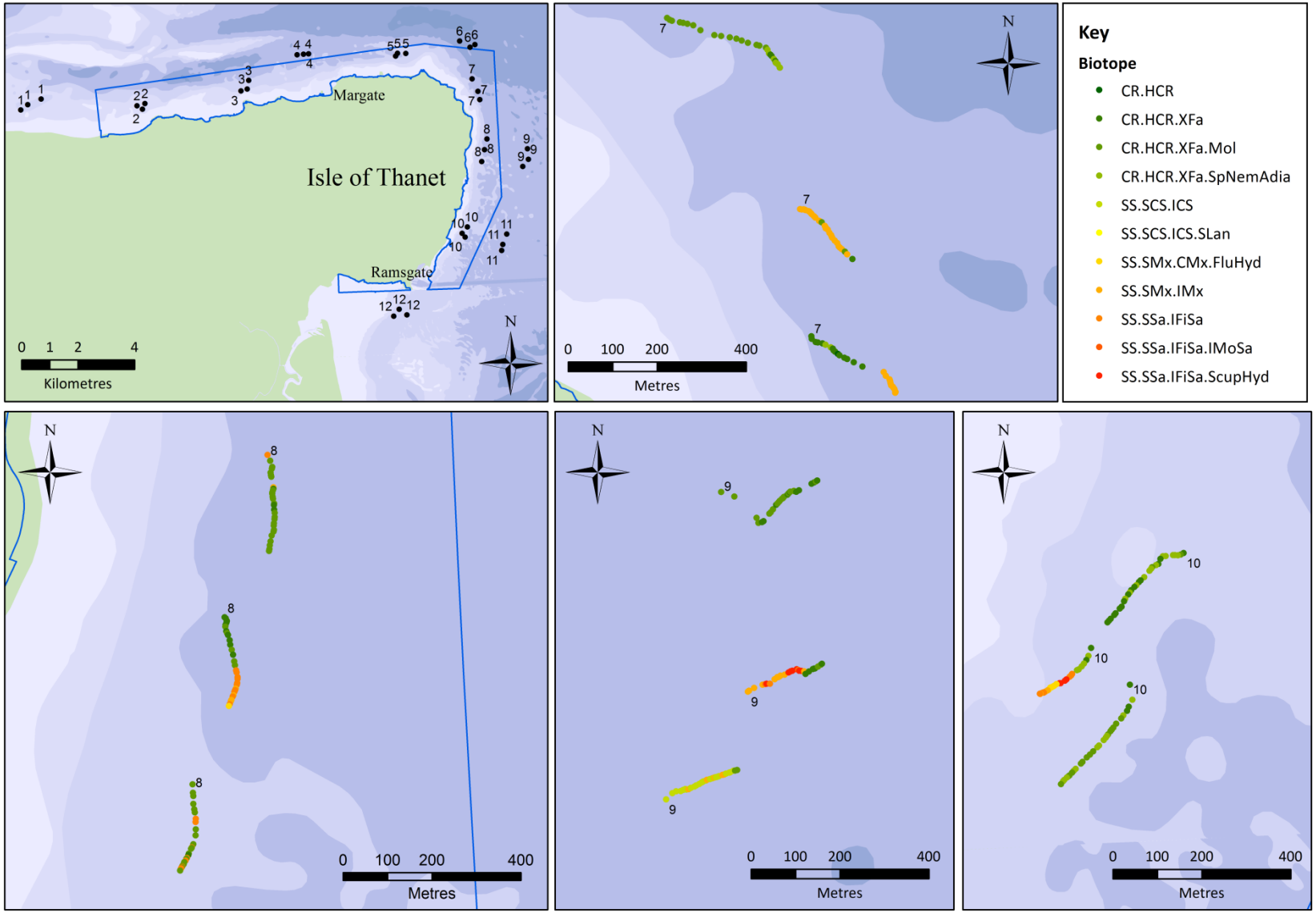

Figure 3.4 Detailed biotope maps (1:10,000) of survey Areas 7 - 10

3.2.11 Area 11 - Open

Area 11 presented the greatest number of different biotopes in the present survey, encompassing eight different biotopes. The most commonly observed biotope in this area was **SS.SMx.IMx** (Figure 3.5), which was encountered where the sediments were well mixed. No particular species characterised this biotope, often only hydroids and *Lanice conchilega* were recorded. **SS.SCS.ICS.SLan** was also a common biotope in this area, characterised by the sand mason worm *L. conchilega* which was often found to form dense aggregations. Hydroid species were occasionally recorded, while the conspicuous species *Hydrallmania falcata* and *Nemertesia antennina* were also identified in this biotope. **SS.SMx.CMx.FluHyd** was the second most frequently assigned biotope in Area 11, and was identified where the bryozoa *Flustra foliacea* and *Alcyonidium diaphanum* were present amongst hydroids on larger cobbles. There were two locations where the biotope **SS.SSa.IFiSa** was recorded, where fine sand supported no epifaunal species. On fine sand with hydroids and the occasional *Alcyonium digitatum* the biotope **SS.SSa.IFiSa.ScupHyd** was recorded.

CR.HCR.XFa was the most frequently observed circalittoral rock biotope in Area 11, representing 12 % of the survey area. **CR.HCR.XFa** was assigned where the sediment was less mixed than any sublittoral sediment biotopes, and consisted more of boulders and bedrock. This biotope contained hydroids including *N. antennina* and *Tubularia indivisa*, and the common starfish *Asterias rubens*. The biotope **CR.HCR.XFa.Mol** was recorded where more heavily silted bed rock and boulders were present. Hydroid species were identified within this biotope, and in one location a branching sponge was recorded. *L. conchilega* was recorded in this biotope together with the anemone *Sagartia elegans.* In locations where the bryozoan *A. diaphanum* was abundant within a more dense turf of hydroids, the biotope **CR.HCR.XFa.SpNemAdia** was recorded.

3.2.12 Area 12 - Open

Area 12 was shown to be dominated by sublittoral sediment. **SS.SSa.IFiSa.IMoSa** represents 33 % of the area (Figure 3.5), and contains sparse epifauna with only mobile species *Opiura ophiura*, *Pagurus bernhardus* and *Asterias rubens* recorded. Additionally, the fine sand biotope **SS.SSa.IFiSa** was recorded widely in Area 12, forming 26 % of biotopes assigned in this area. Mixed sediment was also common within Area 12, with **SS.SMX.IMx** occurring in 23 % of biotope analyses. Within this biotope in Area 12, hydroid species dominated, and *Lanice conchilega* was observed to be abundant. *P. bernhardus and Mytilus edulis* were also observed occasionally within this biotope.

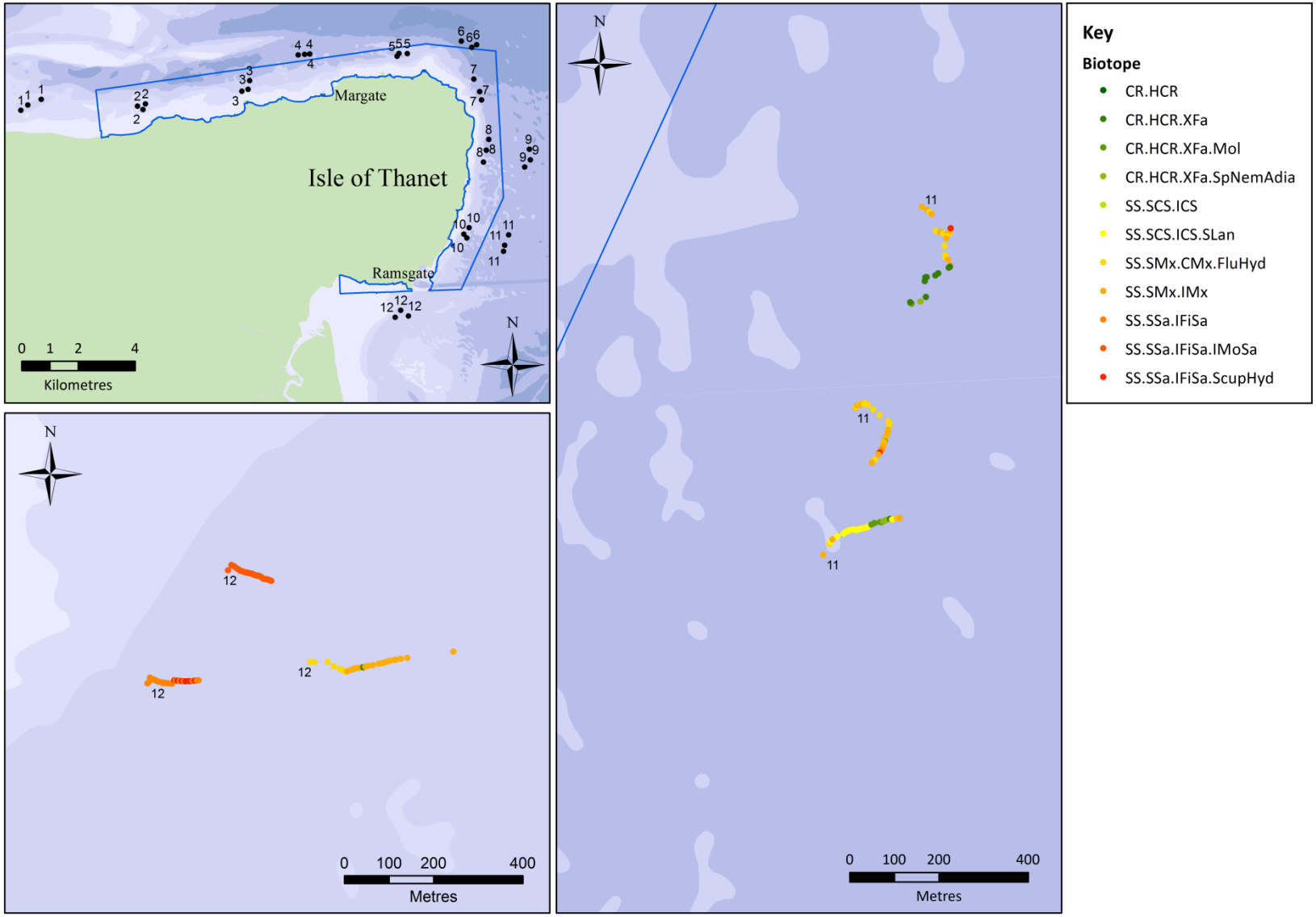

Figure 3.5 Detailed biotope maps (1:10,000) of survey Areas 11 & 12

3.3 Comparison of 2013 data with previous data

Surveys of the benthic habitats surrounding Thanet were conducted in 1995 (Davies 1995) and 1997 (Tittley et al. 1998), and include intertidal and subtidal survey areas. While the marine habitat classification system has been revised between the 1995/1997 and 2013 surveys, approximate comparisons may be made between previous and current observations. Subtidal surveys have indicated the presence of biotopes including **MIR.KR.Ldig.Pid**, which is a very shallow infralittoral biotope, and therefore not possible to survey from a boat using a towed video system. While the biotope **MCR.SfR.Pid** (piddocks with a sparse associated fauna in sublittoral very soft chalk or clay) was the most frequently encountered biotope over the 1995 and 1997 surveys, it was not observed during the present survey. This could be a result of poor visibility that did not allow a clear enough image to observe piddocks using the flying array. The biotope reclassified from **CR.MCR.ByH.Flu.SerHyd** to **SS.SMx.CMx.FluHyd** (*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment) was present in the area surrounding Thanet in previous and current surveys.

The biotope **MCR.As.MolPol** (*Molgula manhattensis* and *Polycarpa* spp. with erect sponges on tide-swept moderately exposed circalittoral rock) was discontinued, but may be reclassified to **XFa** biotopes, including **XFa.Mol** (*M. manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock). The biotope **XFa.Mol** was observed in 194 of 1080 frames analysed (18 % of observations) in the present survey, exhibiting distribution across eight of the 12 areas surveyed.

The biotope formerly known as **MCR.ByHSNemAdia** (sparse sponges, *Nemertesia* spp., *Alcyonidium diaphanum* and *Bowerbankia* spp. on circalittoral mixed substrata) was previously reported only to the northeast of Thanet (Tittley et al. 1998). The present survey indicates the presence of comparable biotopes **SS.SMx.CMx.FluHyd** (*F. foliacea* and *H. falcata* on tide-swept circalittoral mixed sediment) and **CR.HCR.XFa.SpNemAdia** (Sparse sponges, *Nemertesia* spp. and *A. diaphanum* on circalittoral mixed substrata). The distribution of these two biotopes appears to be more widespread in 2013 than in 1995 & 1997, representing a total 13 % of the frames analysed.

3.4 Species assemblage results

A total of 57 taxa from nine phyla were recorded in the surveys; 41 count taxa and 6 cover taxa were recorded in the frame grab analysis and 19 in the video analysis (Appendix 1, Table A3).

Of the species recorded through counts from the quadrat data, hydroids had the greatest mean abundance (203.21 m^{-2} ± 31.84), followed by *Lanice conchilega* (21.1 m^{-2} ± 6.97) and *Tubularia indivisa* (9.916 m^{-2} ± 2.84). “Turf” had the greatest mean percentage cover (14.33 % m^{-2} ± 3.2).

3.4.1 Species richness and abundance

While the mean number of species (species richness) and mean number of organisms (abundance) were greater in the SAC than outside of the SAC, neither was statistically different between treatments (Figure 3.6 & 3.7) (Appendix 1, Table A4.1 & A4.2).

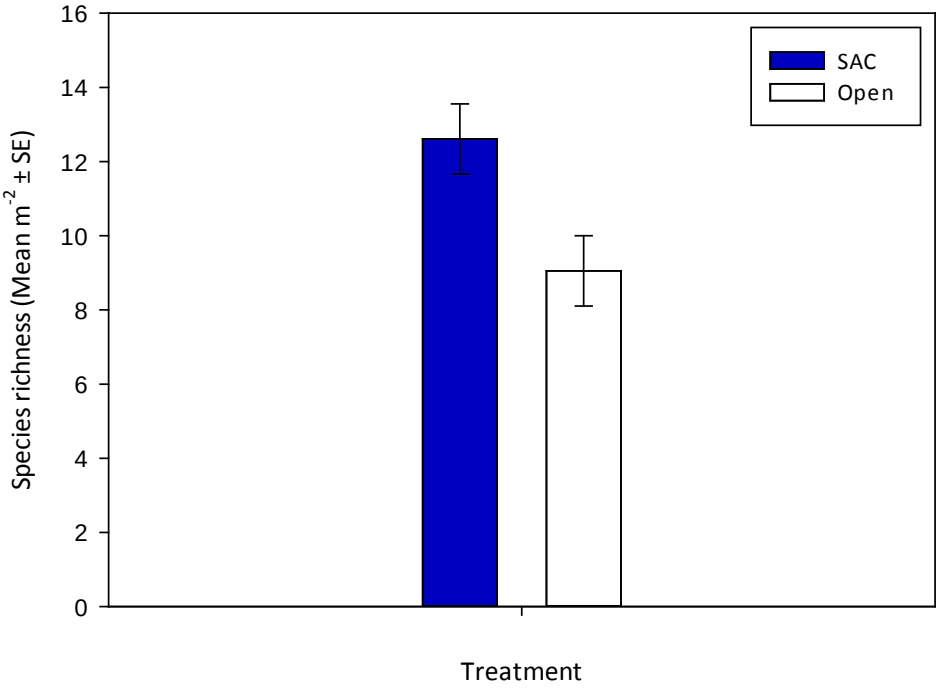

Figure 3.6 Species richness (Mean m-2 ± SE) from frame grab analyses for each treatment (SAC, Open)

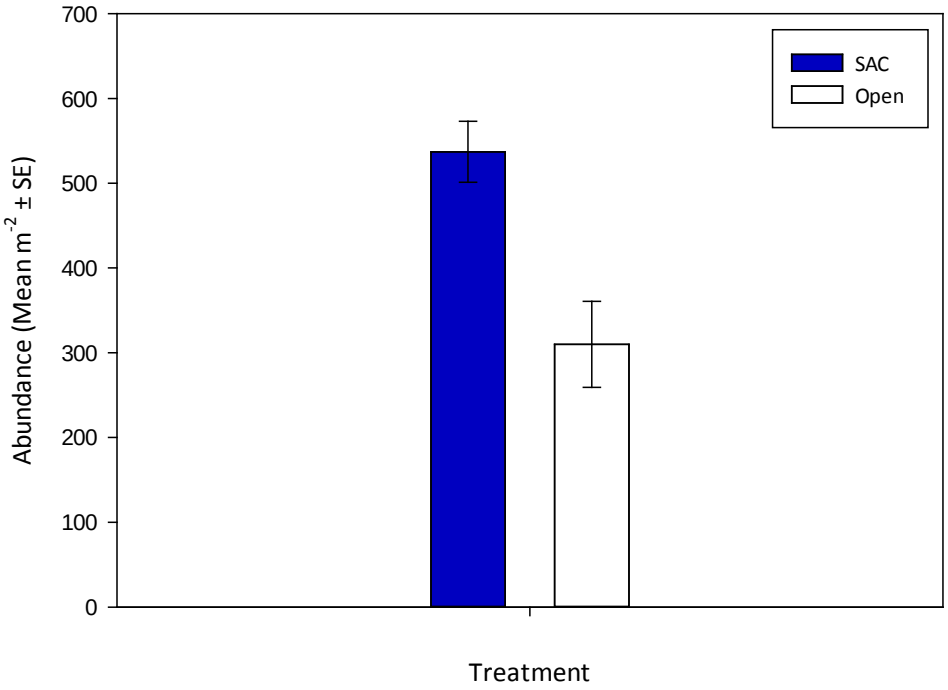

Figure 3.7 Abundance (Mean m-2 ± SE) of count taxa from frame grab analyses for each treatment (SAC, Open)

3.4.2 Indicator species abundance

Abundance of indicator species from the frame grab analyses (*Alcyonidium diaphanum, Alcyonium digitatum,* Flustridae and hydroids) and video analyses (*Asterias rubens, Ophiura ophiura, Pagurus bernhardus* and *Urticina felina*) did not differ significantly between Treatments (SAC and Open) (Figure 3.8 & 3.9) (Appendix 1, Table A4.3- A4.10).

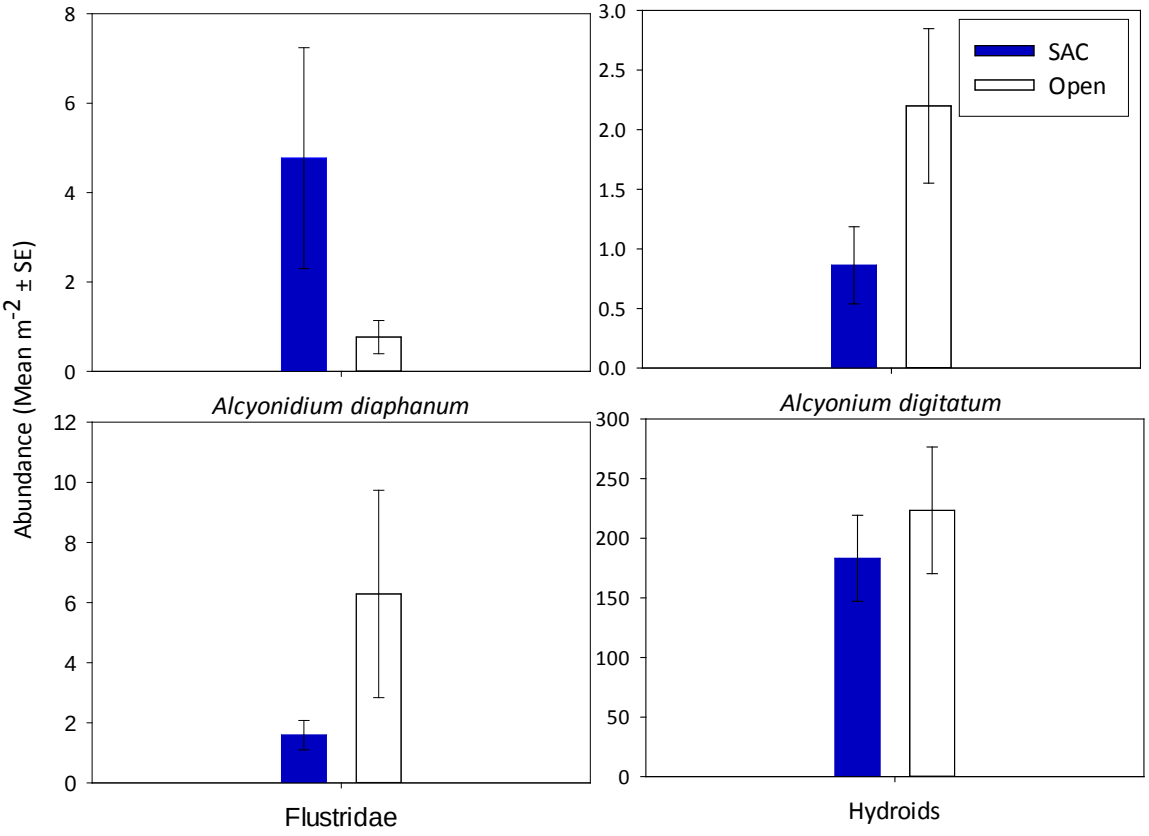

Figure 3.8 Abundance (Mean m^{-2} ± SE) of indicator species from frame grab analyses for each treatment (SAC, Open)

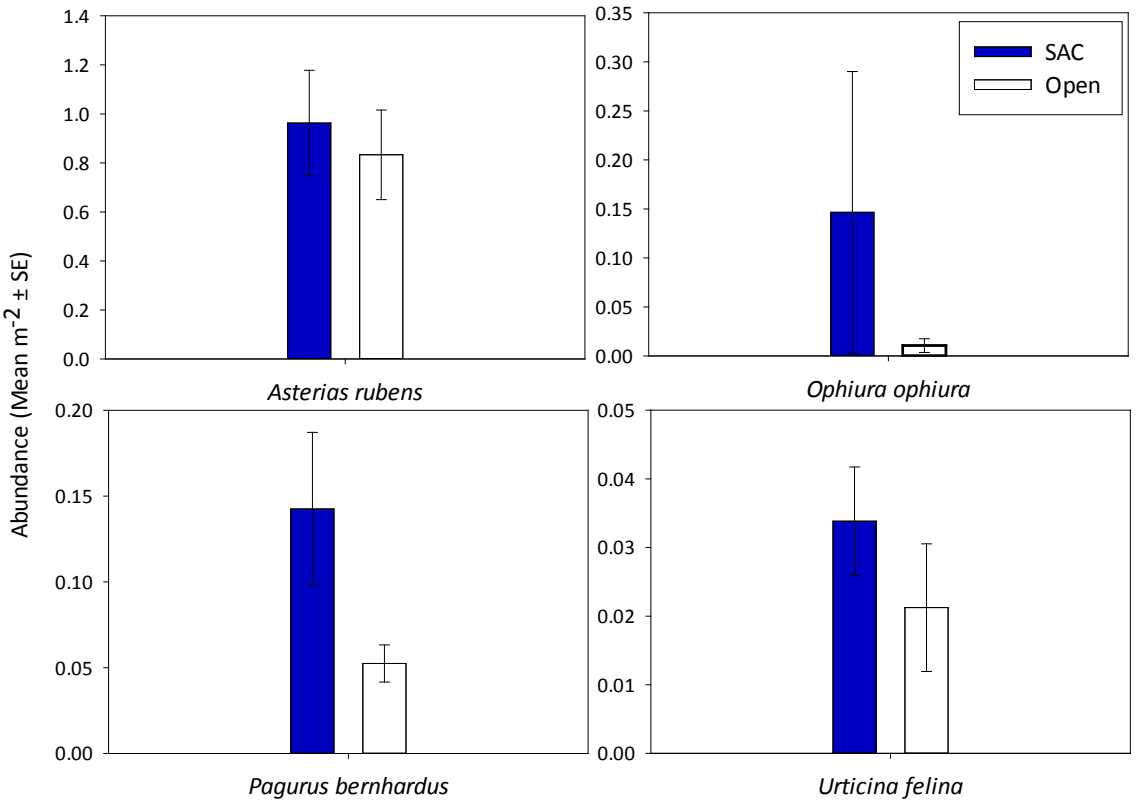

Figure 3.9 Abundance (Mean m-2 ± SE) of indicator species from video transect analyses for each treatment (SAC, Open)

3.4.3 Assemblage composition

Assemblages between Treatments (inside or outside of SAC) did not differ but assemblages between Areas were significantly different ($P < 0.03$) (Table 3.4) (Figure 3.10 & 3.11).

SIMPER identified ten taxa as being important in discerning assemblages in the SAC and Open treatments (average dissimilarity 61.93 %). Hydroids make the largest contribution to the difference between Treatments (61.66 % contribution); mean abundance was 183.19 m^{-2} in the SAC and 223.45 m^{-2} outside of the SAC.

The other species contributing most to the dissimilarity between the SAC and Open Treatments were *Lanice conchilega* (10.01 % contribution) which were found in greater abundances in the SAC than in the Open sites (mean abundance SAC 21.45 m^{-2} and Open 20.74 m^{-2}) (Appendix 1, Table A4.11).

Abundance of "Turf", *Tubularia indivisa* and red algae was greater in the SAC (mean abundance 18.7, 16.15 and 9.87 m^{-2}, respectively) compared to the Open Treatment (mean abundance 9.97, 3.69 and 2.58 m^{-2}, respectively) (Appendix 1, Table A4.11).

Table 3.4 PERMANOVA to compare assemblage composition using frame grabs between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference

Source	*df*	SS	MS	*F*	P
Treatment Tr	1	2116.8	2116.8	0.72308	0.6982
Area Ar(Tr)	10	29275	2927.5	3.2552	**0.0001**
Site (Ar(Tr))	24	21584	899.34	No test	
Total	52976				

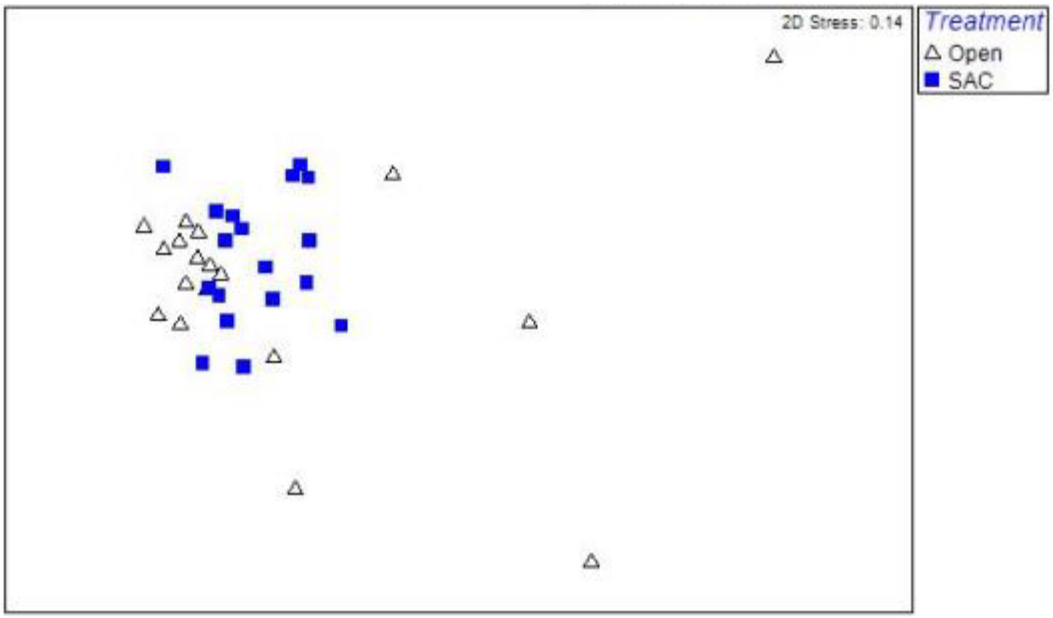

Figure 3.10 nMDS plot showing the degree of similarity (Bray-Curtis) in Assemblage composition between Treatments (averaged for site within treatment), (SAC = blue squares, Open = clear triangles). Data have been 4^{th} root transformed

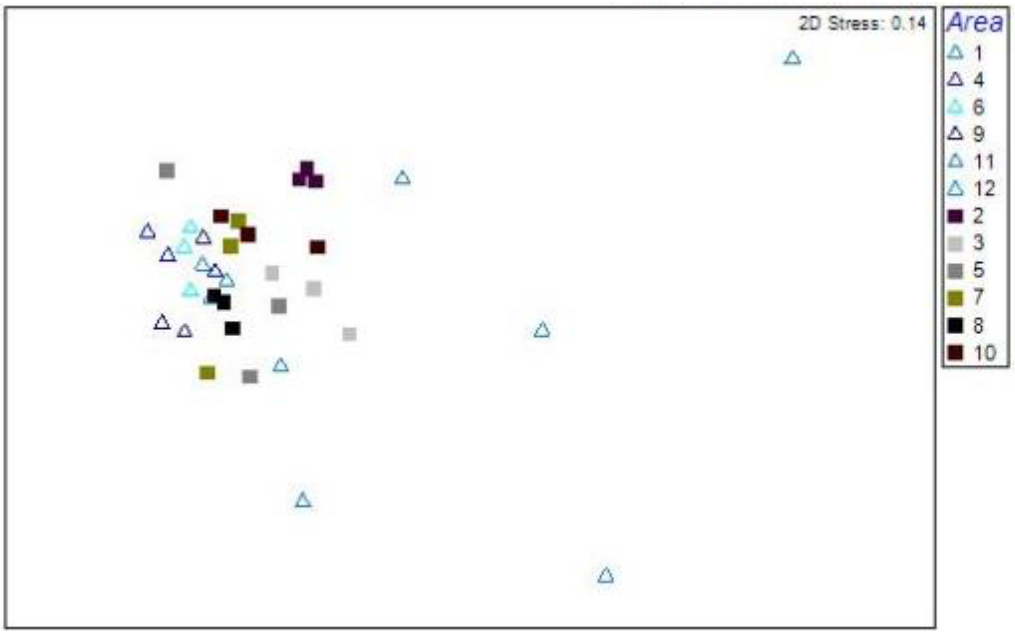

Figure 3.11 nMDS plot showing the degree of similarity (Bray-Curtis) in assemblage composition between Areas (averaged for Site within Area). Squares represent SAC Treatment and triangles represent Open Treatment, while colours are area-specific. Data have been 4th root transformed

3.5 Observed human influences during survey

A number of human influences on the Thanet SAC were observed during the 2013 survey. 80 tonnes of whelk, lobster and crab were landed in July 2012 by potting (MMO 2013) and potters were observed during the July 2013 survey. Maintenance vessels for the London Array wind farm were seen travelling through the SAC between the maintenance base in Ramsgate and the wind farm offshore. In addition marine litter was observed during the 2013 survey. A large square of plastic was seen floating in the video in Area 1 to the west of the SAC and a large balloon was retrieved by the team during the survey after it was seen floating in the water (Figure 3.12). Anglers and bird watchers were also seen during the survey.

Figure 3.12 Marine litter observed during video survey in Area 1 outside of the SAC (left) and collected from the surface (right)

4 Discussion and conclusions

4.1 Comparison between biotopes and assemblages

Circalittoral rock biotopes were more often found to the north and North West of the coastline but there was no clear difference between the inside and outside of the SAC (Fig. 3.1). Areas 12 and 1, both outside of the SAC, contained the most sandy of the sublittoral sediment biotopes. In these biotopes, particularly **SS.SSa.IFiSa.IMoSa**, the characterising species were infaunal, which cannot be recorded using video analysis but the physical characteristics of the area determined these infralittoral fine sand biotopes. Infaunal samples would be needed to ground truth these biotopes. Inside the SAC the biotopes were more varied, supporting different communities whereas outside the SAC there were areas that contained invariably circalittoral rock biotopes (Fig. 3.3 - Areas 4 & 6). Dense beds of *Lanice conchilega* were only recorded outside the SAC on infralittoral coarse sediment. This is probably because the coarse sediment habitat required for these species to live in close proximity was not recorded inside the SAC.

No infralittoral rock biotopes were recorded despite much of the surveyed area being at depths normally associated with infralittoral biotopes. Because of the high turbidity, light that would normally penetrate the water at these depths was not reaching the seabed and therefore the normal photic communities were not supported.

There was no significant difference in the number of species or the number of organisms observed inside the Thanet SAC compared to outside, though the mean of both response variables were greater in the SAC. The assemblages between Areas and Treatments were clearly very patchy depending on habitat type and depth. The data collected here provide a baseline for future comparison to assess potential recovery of species inside the SAC relative to outside the SAC where the habitats are not protected. The use of appropriate control sites will permit robust comparisons to be made between the present survey and future surveys. The sampling and statistical methods employed in this survey have been shown to detect recovery over time following the implementation of restrictions to bottom trawling in Lyme Bay (Stevens et al. 2013). By applying the same approach to sampling and analysis in the monitoring of Thanet Coast SAC in future surveys, it will be possible to identify change over time.

Interestingly, only one of the habitat-building sessile indicator taxa *Alcyonidium diaphanum* tended to be more abundant inside the SAC, whereas *Alcyonium digitatum,* Flustridae and Hydroids were more abundant outside of the SAC. On the whole there was not much evidence to suggest that the SAC was providing protection to the sessile benthic species. Conversely all four mobile/sedentary indicator species *Asterias rubens, Ophiura ophiura, Pagurus bernhardus* and *Urticina felina* tended to be more abundant inside the SAC but none of these trends were statistically significant.

4.2 Future monitoring recommendations

To robustly assess condition of the Thanet SAC, the species assemblages observed in the 2013 survey need to be compared over time. This survey should ideally be repeated annually to monitor change inside the SAC relative to the Open controls. Areas and Sites should be monitored using the same sampling methods and GPS targets. Transects need to be located independently of each other, but as tides, waves and wind dictate the direction of

travel for the flying array it would be recommended that the same start locations are used to ensure that comparable habitats are sampled between years.

5 Acknowledgements

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Appendix 1

List of dominant biotopes

Table A1 Thanet video survey - dominant biotope and transect centroids (OSGB36)

Area	Dominant biotope	X	Y
1	SS.SSa.IFiSa.IMoSa	624748.06	170659.82
1	SS.SSa.IFiSa.ScupHyd	624032.10	170273.80
1	SS.SSa.IFiSa	624274.90	170464.10
2	CR.HCR.XFa.Mol	628145.20	170420.86
2	CR.HCR.XFa.Mol	628340.91	170303.51
2	SS.SMx.CMx.FluHyd	628425.11	170502.22
3	SS.SSa.IFiSa	631830.92	170950.54
3	SS.SSa.IFiSa	632047.26	171013.04
3	SS.SSa.IFiSa	632103.71	171320.12
4	CR.HCR.XFa	634227.53	172263.11
4	CR.HCR.XFa	634047.05	172250.40
4	CR.HCR.XFa	633820.40	172231.02
5	CR.HCR.XFa	637306.74	172186.83
5	SS.SSa.IFiSa	637375.22	172283.40
5	SS.SSa.IFiSa	637669.68	172280.33
6	CR.HCR.XFa	639574.02	172714.95
6	CR.HCR.XFa	639945.62	172500.49
6	CR.HCR.XFa	640119.21	172591.56
7	CR.HCR.XFa.Mol	640016.51	171376.39
7	SS.SMx.IMx	640223.76	170938.66
7	SS.SMx.IMx	640292.07	170640.41
8	CR.HCR.XFa.Mol	640541.68	169246.35
8	CR.HCR.XFa	640457.29	168865.82
8	CR.HCR.XFa.Mol	640355.76	168447.73
9	CR.HCR.XFa.Mol	641978.27	168903.67
9	SS.SMx.IMx	642012.70	168524.59
9	SS.SCS.ICS	641814.55	168275.18
10	CR.HCR.XFa	639850.11	166131.25
10	SS.SSa.IFiSa	639664.32	165904.64
10	CR.HCR.XFa.Mol	639767.43	165771.82
11	SS.SCS.ICS.SLan	641062.39	165295.52
11	SS.SMx.IMx	641108.05	165508.65
11	CR.HCR.XFa	641243.56	165875.89
12	SS.SMx.IMx	637707.44	163014.21
12	SS.SSa.IFiSa	637239.94	162971.49
12	SS.SSa.IFiSa.IMoSa	637435.53	163213.37

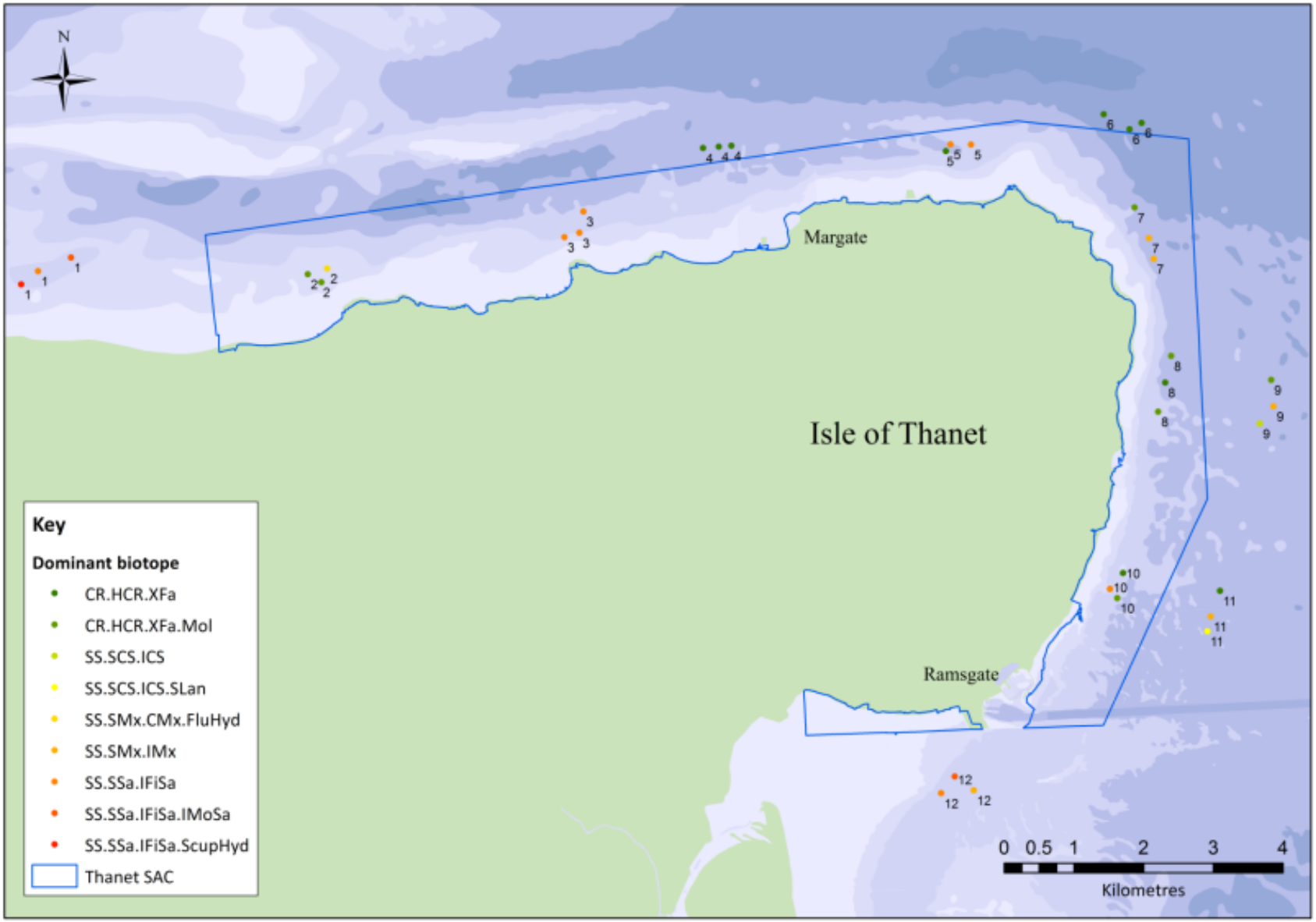

Figure A1 Dominant biotope for survey areas

Local biotope classifications by survey area

Since biotope classifications are based on a number of different features which may or may not be present, each survey area has been listed with its most abundant species in Table A2, below.

Table A2 Most abundant species related to biotopes by survey area

Area	Biotope	Abundant species	Mean abundance, m^{-2}
1	SS.SSa.IFiSa	Red algae	10.62
		Hydroids	1.48
		Cerianthid spp.	2.47
		Pagurus bernhardus	0.59
		Asterias rubens	0.3
1	SS.SSa.IFiSa.IMoSa	Red algae	0.49
1	SS.SSa.IFiSa.ScupHyd	Red algae	34.81
		Hydroids	13.04
		Flustridae	4
		Mixed Bryozoan & Hydroid turf < 1cm tall	2.5
2	CR.HCR.XFa.Mol	Hydroids	232.84
		Mixed Bryozoan & Hydroid turf < 1cm tall	57.48
		Alcyonidium diaphanum	20.32
		Red algae	43.86
		Flustridae	3.28
		Alcyonium digitatum	0.16
		Urticina felina	2.2
		Sagartia elegans	1.39
		Asterias rubens	1.67
2	SS.SMx.CMx.FluHyd	Hydroids	152.11
		Mixed Bryozoan & Hydroid turf < 1cm tall	45.4
		Red algae	51.39
		Alcyonidium diaphanum	33.79
		Flustridae	3.99
		Cerianthid spp.	0.33
		Asterias rubens	2.16
3	CR.HCR.XFa.Mol	Hydroids	624.84
		Lanice conchilega	137.21
		Tubularia indivisa	92.46
		Red algae	1.05
		Cerianthid spp.	10.89
		Sagartia elegans	8.19
		Flustridae	8.15
		Mixed Bryozoan & Hydroid turf < 1cm tall	6.62
		Macroalgae	6.97
		Metridium senile	6.14
		Alcyonidium diaphanum	3.88
3	CR.HCR.XFa.SpNemAdia	Hydroids	533.33
		Cerianthid spp.	53.33
		Macroalgae	35.56
		Ophiura ophiura	8.89

Table A2 continued…

Area	Biotope	Abundant species	Mean abundance, m^{-2}
3	SS.SSa.IFiSa	Hydroids	261.44
		Lanice conchilega	66.61
		Red algae	1.94
		Ophiura ophiura	6.95
		Metridium senile	0.16
		Asterias rubens	3.94
		Macroalgae	1.56
3	SS.SSa.IFiSa.ScupHyd	Hydroids	688.89
		Nemertesia antennina	77.78
		Tubularia indivisa	66.67
		Macroalgae	44.44
		Mixed Bryozoan & Hydroid turf < 1cm tall	6.25
		Cerianthid spp.	11.11
4	CR.HCR.XFa	*Nemertesia antennina*	4.01
		Flustridae	18.49
		Lanice conchilega	16.59
		Hydroids	462.83
		Metridium senile	18.91
		Tubularia indivisa	10.99
		Alcyonidium diaphanum	0.12
		Anemone	3.13
		Mixed Bryozoan & Hydroid turf < 1cm tall	24.65
4	CR.HCR.XFa.SpNemAdia	*Nemertesia antennina*	107
		Flustridae	68.81
		Lanice conchilega	4.44
		Hydroids	471.6
		Metridium senile	10.7
		Tubularia indivisa	3.29
		Alcyonidium diaphanum	7.24
		Mixed Bryozoan & Hydroid turf < 1cm tall	27.43
		Alcyonium digitatum	3.13
5	CR.HCR	Mixed Bryozoan & Hydroid turf < 1cm tall	6.25
5	CR.HCR.XFa	Hydroids	195.07
		Mixed Bryozoan & Hydroid turf < 1cm tall	29.08
		Alcyonidium diaphanum	4.25
		Branching sponge 2	1.74
		Asterias rubens	0.87
		Branching sponge 1	1.35
5	CR.HCR.XFa.Mol	Hydroids	110.37
		Mixed Bryozoan & Hydroid turf < 1cm tall	27.08
		Alcyonium digitatum	13.58
		Alcyonidium diaphanum	2.47
		Branching sponge 1	1.85
		Branching sponge 2	1.85
		Asterias rubens	1.48

Table A2 continued…

Area	Biotope	Abundant species	Mean abundance, m^{-2}
5	SS.SSa.IFiSa	Red algae	0.85
		Hydroids	45.3
		Lanice conchilega	31.44
		Metridium senile	6.62
		Flustridae	0.38
		Tubularia indivisa	2.02
		Mixed Bryozoan & Hydroid turf < 1cm tall	0.66
		Cerianthid spp.	1.47
		Red algae	0.85
5	SS.SSa.IFiSa.ScupHyd	Hydroids	285.01
		Lanice conchilega	61.14
		Red algae	0.68
		Metridium senile	20.68
		Tubularia indivisa	5.47
		Mixed Bryozoan & Hydroid turf < 1cm tall	5.77
		Flustridae	0.85
		Alcyonidium diaphanum	1.71
		Cerianthid spp.	2.91
		Alcyonium digitatum	0.85
		Sabella pavonina	1.37
6	CR.HCR.XFa	Hydroids	310.22
		Mixed Bryozoan & Hydroid turf < 1cm tall	27.83
		Lanice conchilega	12.9
		Alcyonium digitatum	6.24
		Nemertesia antennina	1.83
		Flustridae	3.7
		Anemone	0.13
6	CR.HCR.XFa.SpNemAdia	Hydroids	288.89
		Lanice conchilega	35.56
		Nemertesia antennina	20
		Alcyonium digitatum	11.11
7	CR.HCR	No identifiable species	
7	CR.HCR.XFa	Hydroids	160.33
		Mixed Bryozoan & Hydroid turf < 1cm tall	17.36
		Red algae	22.22
		Asterias rubens	12.47
		Sagartia elegans	3.95
		Urticina felina	2.47
		Alcyonidium diaphanum	0.99
		Nemertesia antennina	0.49
		Tubularia indivisa	1.98
		Alcyonium digitatum	1.32

Table A2 continued…

7	CR.HCR.XFa.Mol	Hydroids	249.59

Area	Biotope	Abundant species	Mean abundance, m^{-2}
7	CR.HCR.XFa.Mol	Hydroids	249.59
		Mixed Bryozoan & Hydroid turf < 1cm tall	16.56
		Lanice conchilega	10.37
		Tubularia indivisa	7.26
		Asterias rubens	5.63
		Cerianthid spp.	4.41
		Flustridae	0.44
		Alcyonium digitatum	3.11
		Urticina felina	1.56
		Pagurus bernhardus	1.33
7	CR.HCR.XFa.SpNemAdia	Hydroids	249.7
		Tubularia indivisa	85.48
		Red algae	5.33
		Mixed Bryozoan & Hydroid turf < 1cm tall	28.13
		Alcyonium digitatum	12.67
		Sagartia elegans	11.56
		Cerianthid spp.	10.89
		Nemertesia antennina	7.78
		Asterias rubens	6.81
		Flustridae	1.11
		Alcyonidium diaphanum	4.15
7	SS.SMx.IMx	Red algae	0.22
		Lanice conchilega	2.51
		Hydroids	3.97
		Cerianthid spp.	0.22
		Asterias rubens	1.45
		Tubularia indivisa	0.72
		Mixed Bryozoan & Hydroid turf < 1cm tall	0.3
8	CR.HCR.XFa	Hydroids	146.03
		Mixed Bryozoan & Hydroid turf < 1cm tall	12.95
		Nemertesia antennina	5.71
		Asterias rubens	5.08
		Lanice conchilega	4.44
		Metridium senile	3.17
		Tubularia indivisa	3.17
		Alcyonium digitatum	0.63
		Sagartia elegans	0.63
8	CR.HCR.XFa.Mol	Hydroids	98.67
		Tubularia indivisa	53.23
		Lanice conchilega	22.47
		Mixed Bryozoan & Hydroid turf < 1cm tall	3.63
		Asterias rubens	3.3
		Nemertesia antennina	2.84
		Flustridae	1.48
		Alcyonium digitatum	0.83
		Pagurus bernhardus	0.18
		Alcyonidium diaphanum	0.3

Table A2 continued…

Area	Biotope	Abundant species	Mean abundance, m^{-2}
8	SS.SMx.CMx.FluHyd	*Tubularia indivisa*	177.78
		Flustridae species	14.81
8	SS.SMx.IMx	Hydroids	17.78
		Tubularia indivisa	5.33
		Mixed Bryozoan & Hydroid turf < 1cm tall	2.5
		Asterias rubens	1.78
		Pagurus bernhardus	1.78
8	SS.SSa.IFiSa	*Lanice conchilega*	0.44
		Pagurus bernhardus	0.89
		Asterias rubens	1
9	CR.HCR.XFa	Hydroids	516.17
		Nemertesia antennina	19.48
		Mixed Bryozoan & Hydroid turf < 1cm tall	9.93
		Sagartia elegans	8.85
9	CR.HCR.XFa.Mol	Hydroids	826.09
		Lanice conchilega	56.75
		Red algae	0.64
		Nemertesia antennina	29.5
		Sagartia elegans	20.81
		Tubularia indivisa	11.59
		Flustridae	1.77
		Mixed Bryozoan & Hydroid turf < 1cm tall	9.24
9	SS.SCS.ICS	Hydroids	11.53
		Lanice conchilega	1.16
		Alcyonidium diaphanum	0.39
		Asterias rubens	0.64
9	SS.SMx.IMx	Hydroids	146.41
		Nemertesia antennina	0.52
		Mixed Bryozoan & Hydroid turf < 1cm tall	0.74
		Nemertesia antennina	1.27
		Cerianthid spp.	6.35
		Sagartia elegans	4.23
9	SS.SSa.IFiSa	Hydroids	29.63
		Nemertesia antennina	2.96
9	SS.SSa.IFiSa.ScupHyd	Hydroids	501.59
10	CR.HCR.XFa	Hydroids	152.28
		Mixed Bryozoan & Hydroid turf < 1cm tall	54.17
		Red algae	1.83
		Tubularia indivisa	12.28
		Asterias rubens	5.5
		Nemertesia antennina	1.69
		Flustridae species	0.95
		Urticina felina	1.27
		Buccinum undatum	0.71

Table A2 continued…

Area	Biotope	Abundant species	Mean abundance, m^{-2}
10	CR.HCR.XFa.Mol	Hydroids	411.2
		Mixed Bryozoan & Hydroid turf < 1cm tall	47.79
		Tubularia indivisa	38.13
		Lanice conchilega	21.79
		Nemertesia antennina	9.41
		Red algae	4.71
		Flustridae	2.22
		Alcyonidium diaphanum	0.87
		Encrusting sponge 2	1.1
		Asterias rubens	5.58
		Alcyonium digitatum	1.05
		Sagartia elegans	1.18
10	CR.HCR.XFa.SpNemAdia	Hydroids	368.71
		Tubularia indivisa	67.23
		Mixed Bryozoan & Hydroid turf < 1cm tall	34.91
		Red algae	11.47
		Nemertesia antennina	12.59
		Asterias rubens	8.3
		Flustridae	6.79
		Lanice conchilega	0.38
		Massive sponge 5	3.75
		Alcyonium digitatum	2.89
		Encrusting sponge 5	2.8
10	SS.SMx.CMx.FluHyd	Hydroids	105.4
		Red algae	1.27
		Tubularia indivisa	7.62
		Lanice conchilega	5.93
		Encrusting sponge 5	4.46
		Flustridae	1.27
		Urticina felina	2.12
10	SS.SMx.IMx	No epifaunal species	
10	SS.SSa.IFiSa	*Lanice conchilega*	1.39
10	SS.SSa.IFiSa.ScupHyd	*Lanice conchilega*	77.78
		Hydroids	25
		Tubularia indivisa	7.41
11	CR.HCR.XFa	Hydroids	247.81
		Tubularia indivisa	11.58
		Lanice conchilega	8.62
		Asterias rubens	6.46
		Sagartia elegans	4.04
		Flustridae species	1.62
		Mixed Bryozoan & Hydroid turf < 1cm tall	0.57
		Alcyonium digitatum	1.62
		Nemertesia antennina	2.42

Table A2 continued…

Area	Biotope	Abundant species	Mean abundance, m^{-2}
11	CR.HCR.XFa.Mol	Hydroids	296.3
		Alcyonidium diaphanum	29.63
		Lanice conchilega	19.56
		Flustridae	14.81
		Sagartia elegans	8.89
		Nemertesia antennina	7.7
		Mixed Bryozoan & Hydroid turf < 1cm tall	8.75
		Alcyonium digitatum	5.93
		Cerianthid spp.	2.96
		Tubularia indivisa	5.93
		Asterias rubens	1.78
11	CR.HCR.XFa.SpNemAdia	Hydroids	229.63
		Alcyonium digitatum	34.07
		Mixed Bryozoan & Hydroid turf < 1cm tall	25
		Flustridae	22.22
		Nemertesia antennina	7.41
		Asterias rubens	6.67
		Lanice conchilega	2.22
11	SS.SCS.ICS.SLan	*Lanice conchilega*	291.55
		Hydroids	185.4
		Nemertesia antennina	5.32
		Flustridae	0.87
		Mixed Bryozoan & Hydroid turf < 1cm tall	0.37
		Alcyonium digitatum	1.31
11	SS.SMx.CMx.FluHyd	Hydroids	114.2
		Lanice conchilega	28.4
		Asterias rubens	5.19
		Tubularia indivisa	4.07
		Nemertesia antennina	2.84
		Alcyonium digitatum	2.59
		Flustridae	6.3
		Pagurus bernhardus	1.48
		Sagartia elegans	0.37
		Alcyonidium diaphanum	1.11
11	SS.SMx.IMx	Hydroids	65.9
		Lanice conchilega	16.83
		Asterias rubens	2.01
		Tubularia indivisa	1.07
		Mixed Bryozoan & Hydroid turf < 1cm tall	0.25
		Alcyonium digitatum	0.36
		Nemertesia antennina	0.71
11	SS.SSa.IFiSa	No epifaunal species	
11	SS.SSa.IFiSa.ScupHyd	*Tubularia indivisa*	296.3
		Hydroids	222.22
		Lanice conchilega	103.7
		Alcyonium digitatum	7.41

Table A2 continued…

Area	Biotope	Abundant species	Mean abundance, m^{-2}
12	CR.HCR.XFa	Encrusting sponge 2	56.25
		Pagurus bernhardus	8.89
12	SS.SMx.CMx.FluHyd	Hydroids	205.56
		Alcyonidium diaphanum	6.67
		Mixed Bryozoan & Hydroid turf < 1cm tall	7.81
12	SS.SMx.IMx	Hydroids	65.08
		Lanice conchilega	32.38
		Pagurus bernhardus	1.48
		Mytilus edulis	0.95
		Calliactis parasitica	0.42
12	SS.SSa.IFiSa	*Lanice conchilega*	6.57
		Pagurus bernhardus	1.55
12	SS.SSa.IFiSa.IMoSa	*Ophiura ophiura*	1.48
		Pagurus bernhardus	2.07
		Asterias rubens	0.59
12	SS.SSa.IFiSa.ScupHyd	Hydroids	46.98
		Lanice conchilega	6.35
		Pagurus bernhardus	1.27

Species List

Table A3 Species recorded in 2013 Thanet Coast video survey

Species name	Common name
Anemone	Anemone species
Alcyonidium diaphanum	Sea chervil
Alcyonium digitatum	Dead man's finger
Asterias rubens	Common starfish
Branching sponge 1	Thick-fused yellow branching sponge
Branching sponge 2	Thin tapering yellow branching sponge
Buccinum undatum	Common whelk
Calliactis parasitica	Parasitic anemone
Calliostoma zizyphinum	Painted top shell
Cancer pagurus	Brown crab
Carcinus maenas	Common shore crab
Cellepora pumicosa	Orange bryozoan
Cerianthid spp.	Tube-dwelling anemone
Corystes cassivelaunus	Masked crab
Crab	Crab
Echiichthys vipera	Lesser weever fish
Encrusting black algae	Encrusting black algae
Encrusting sponge 2	Yellow encrusting sponge
Encrusting sponge 4	Orange encrusting sponge
Encrusting sponge 5	Yellow uneven encrusting sponge
Encrusting sponge 6	Grey encrusting sponge
Fish	Fish
Flustridae	Erect bryozoan
Goby	Goby species
Halecium halecinum	Herringbone hydroid
Hydrallmania falcata	Hydroid
Hydroids	Hydroid species
Inachus spp.	Scorpion spider crab species
Laminaria spp.	Kelp species
Lanice conchilega	Sand mason worm
Liocarcinus depurator	Harbour crab
Macroalgae	Macroalgae
Macropodia spp.	Spider crab
Massive sponge 1	Grey massive sponge
Massive sponge 2	White massive sponge
Massive sponge 3	Yellow massive sponge
Massive sponge 5	Orange massive sponge
Metridium senile	Plumose anemone
Mytilus edulis	Blue mussel
Nemertesia antennina	Sea beard hydroid
Nudibranch species	Nudibranch species
Ophiura ophiura	Brittlestar
Pagurus bernhardus	Common hermit crab
Phallusia mammillata	White sea squirt
Pholas dactylus	Piddock
Pholis gunnellus	Rock gunnel
Red algae	Red algae
Sabella pavonina	Peacock worm
Sagartia elegans	Anemone
Scyliorhinus canicula	Small-spotted catshark
Sepiola atlantica	Little cuttlefish
Sycon ciliatum	Sponge
Tubularia indivisa	Oaten pipes hydroid
Turf	Mixed bryozoan and hydroid turf < 1 cm
Ulva lactuca	Sea lettuce
Urticina felina	Dahlia anemone

PERMANOVA Tables

Abundance

Table A4.1 PERMANOVA to compare the relative abundance of count species identified using frame grabs between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	*df*	SS	MS	*F*	P
Treatment Tr	1	3.9071	3.9071	0.84567	0.4173
Area Ar(Tr)	10	46.202	4.6202	4.5651	**0.0013**
Site (Ar(Tr))	24	24.29	1.0121	No test	
Total	74.398				

Species Richness

Table A4.2 PERMANOVA to compare the species richness of count species identified using frame grabs between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	*df*	SS	MS	*F*	P
Treatment Tr	1	1.2263	1.2263	3.5784	0.0964
Area Ar(Tr)	10	3.427	0.3427	2.4535	**0.0319**
Site (Ar(Tr))	24	3.3523	0.13968	No test	
Total	8.0055				

Indicator species from frame grab analyses

Alcyonidium diaphanum

Table A4.3 PERMANOVA to compare the relative abundance of *Alcyonidium diaphanum* between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	*df*	SS	MS	*F*	P
Treatment Tr	1	1.2326	1.2326	1.0846	0.3356
Area Ar(Tr)	10	10	11.364	1.1364	4.3771
Site (Ar(Tr))	24	6.7504	0.28127	No test	
Total	31.164				

Alcyonium digitatum

Table A4.4 PERMANOVA to compare the relative abundance of *Alcyonium digitatum* between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	*df*	SS	MS	*F*	P
Treatment Tr	1	1.2326	1.2326	1.0846	0.3356
Area Ar(Tr)	10	11.364	1.1364	4.3771	**0.0018**
Site (Ar(Tr))	24	6.2312	0.25963	No test	
Total	374.27				

Flustridae species

Table A4.5 PERMANOVA to compare the relative abundance of Flustridae species between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	*df*	SS	MS	*F*	P
Treatment Tr	1	0.96987	0.96987	0.47085	0.5879
Area Ar(Tr)	10	20.598	2.0598	3.4134	**0.0071**
Site (Ar(Tr))	24	14.483	0.60345	No test	
Total	36.051				

Hydroid species

Table A4.6 PERMANOVA to compare the relative abundance of Hydroid species between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	*df*	SS	MS	*F*	P
Treatment Tr	1	9.9265	9.9265	0.3842	0.5461
Area Ar(Tr)	10	258.37	25.837	5.8513	**0.0001**
Site (Ar(Tr))	24	105.97	4.4155	No test	
Total	374.27				

Indicator species from video transect analyses

Asterias rubens

Table A4.7 PERMANOVA to compare the relative abundance of *Asterias rubens* between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	*df*	SS	MS	*F*	P
Treatment Tr	1	0.0378	0.0378	0.1146	0.7301
Area Ar(Tr)	10	3.2982	0.3298	3.8484	**0.0041**
Site (Ar(Tr))	24	2.0569	0.0857	No test	
Total	35	5.3929			

Ophiura ophiura

Table A4.8 PERMANOVA to compare the relative abundance of *Ophiura ophiura* between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	*df*	SS	MS	*F*	P
Treatment Tr	1	0.0362	0.0362	0.7880	0.8476
Area Ar(Tr)	10	0.4592	0.0459	1.0108	0.4008
Site (Ar(Tr))	24	1.0904	0.0454	No test	
Total	35	1.5858			

Pagurus bernhardus

Table A4.9 PERMANOVA to compare the relative abundance of *Pagurus bernhardus* between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	***df***	**SS**	**MS**	***F***	**P**
Treatment Tr	1	0.0463	0.0463	1.4058	0.2731
Area Ar(Tr)	10	0.3290	0.0329	9.6535	**0.0001**
Site (Ar(Tr))	24	0.0818	0.0034	No test	
Total	35	0.4571			

Urticina felina

Table A4.10 PERMANOVA to compare the relative abundance of *Urticina felina* between Treatment (SAC vs. Open) and Area (six per treatment). Bold type denotes a statistically significant difference.

Source	***df***	**SS**	**MS**	***F***	**P**
Treatment Tr	1	0.0014	0.0014	1.0033	0.3354
Area Ar(Tr)	10	0.0139	0.0014	1.2321	0.3003
Site (Ar(Tr))	24	0.0271	0.0011	No test	
Total	35	0.0424			

SIMPER

Table A4.11 SIMPER analysis showing which species contributed the greatest differences to assemblages at the SAC and Open sites

		SAC	Open				
Species	**Common name**	**Av. Abundance**	**Av. Abundance**	**Av. Dissimilarity**	**Dissimilarity /SD**	**% contribution**	**Cumulative %**
Hydroids	Hydroids	223.45	183.19	38.18	1.7	61.66	61.66
Lanice conchilega	Sand mason	20.74	21.45	6.2	0.68	10.01	71.67
Turf	Turf	9.97	18.7	4.14	0.9	6.68	78.35
Tubularia indivisa	Hydroid	3.69	16.15	3.87	0.72	6.26	84.6
Red algae	Red algae	2.58	9.87	2.82	0.54	4.55	89.15
Flustridae	Flustridae	6.29	1.59	1.09	0.49	1.76	90.92
Alcyonidium diaphanum	Sea chervil	0.77	4.77	1.03	0.44	1.66	92.58
Nemertesia antennina	Sea beard	6.96	1.75	0.94	0.74	1.52	94.1
Asterias rubens	Common sea star	1.57	3.08	0.69	0.73	1.12	95.22
Metridium senile	Plumose anemone	2.88	1.37	0.67	0.49	1.09	96.31